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1888/89

Geology

ANNUAL REPORT

AND

TRANSACTIONS

OF THE

PLYMOUTH INSTITUTION

AND

Devon & Cornwall Natural History Society.

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VOL. X. PART II. 1888-89.

PLYMOUTH:
W. BRENDON AND SON, GEORGE STREET.
1889.

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MEMBERS AND ASSOCIATES,

BALANCE SHEET, ANNUAL REPORT,

AND

METEOROLOGICAL REPORT AND REGISTER.

1888–89.

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OFFICERS OF THE INSTITUTION.

SESSION 1888-89.

President:

Mr. G. JACKSON, F.R.C.S.

Vice-Presidents:

Rev. Prof. CHAPMAN, LL.D.
Mr. F. H. BALKWILL.
Mr. G. JAGO.
Mr. R. N. WORTH, F.G.S.

Treasurers:

Mr. S. CATER.
Mr. R. N. WORTH, F.G.S.

Secretaries:

Mr. J. C. INGLIS, C.E.
Mr. H. PENROSE PRANCE.

Librarian and Editor of Transactions:

Mr. J. BROOKING ROWE, F.S.A., F.L.S.

Members of Council:

Mr. F. BRENT, F.S.A.
Mr. R. BURNARD.
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Mr. H. M. EVANS.
Mr. P. MITCHELL, R.I.
Dr. J. MERRIFIELD, F.R.A.S., F.R.M.S.
Dr. R. OXLAND, F.C.S.
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Mr. F. J. WEBB, F.G.S.

The above form the Council.

Curators:

Building—Mr. J. C. INGLIS, C.E.
Fine Arts—Mr. P. MITCHELL, R.I.

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Anthropology—Mr. F. BRENT, F.S.A.
Mammals and Osteology—Mr. F. H. BALKWILL.
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Invertebrates—Mr. G. BIGNELL, F.E.S. Mr. F. BRENT, F.S.A. Mr. J. T. CUNNINGHAM, B.A., F.R.S.E.
Botany—Mr. D. D. DOBELL.
Mineralogy—Dr. R. OXLAND, F.C.S.
Geology—Mr. F. J. WEBB, F.G.S.
Petrology—Mr. R. N. WORTH, F.G.S.

LIST OF MEMBERS.

HONORARY MEMBERS.

Elected.	Name.	Address.
1865	Adams, J. C., D.C.L., F.R.A.S.	The Observatory, Cambridge.
1877	Beal, Rev. Professor, B.A., M.R.A.S., D.C.L.,	Green Norton Rectory, Towcaster.
1887	Dallinger, Rev. W. H., LL.D., F.R.S., etc.,	Wesley College, Sheffield.
1874	Froude, James Anthony, M.A.	5, Onslow Gardens, London, W.
1859	Gibbs, F. W., Q.C., C.B.,	24, Mount Street, Grosvenor Square, London, W.
1877	Günther, Dr. A., F.R.S., F.L.S., F.Z.S.	British Museum, London.
1887	Lankester, Ray, Professor, F.R.S.	North Bank, London, N.W.
1865	Lubbock, Sir John, Bart., D.C.L., F.R.S., F.L.S.,	High Elms, Kent.
1874	Pengelly, W., F.R.S., F.G.S.	Lamorna, Torquay.
1859	Scrivener, Rev. F. H. A., M.A., LL.D.	Hendon, Middlesex.
1875	Temple, Right Rev. Dr., Bishop of London,	The Palace, Fulham.
1865	Vivian, Edward, M.A.	Torquay.
1872	Weymouth, R. F., D.LIT.	33, Alfred Road, Acton, London.
1872	Worth, R. N., F.G.S.	4, Seaton Road.

LIFE MEMBERS.

1855	Alger, J.	Sydney, Australia.
1863	Alger, W. H.	Manor House, Stoke.
1856	Bartlett, G.	Plymouth.

CORRESPONDING MEMBERS.

1887	Iago, Rev. W., B.A.	Bodmin.
1858	Ormerod, G. W., M.A., F.G.S.	Woodway, Teignmouth.
1863	Vicary, W., F.G.S.	Exeter.

LECTURING MEMBERS.

1868	Adams, W.	Frankfort Street.
1881	Aldridge, Charles, M.D.	Plympton House, Plympton.
1860	Anthony, Rev. Professor, M.A.	13, Woodland Terrace.
1884	Babb, H. R.	21, Portland Square.
1864	Balkwill, Francis Hancock	Princess Square.
1852	Bate, C. Spence, F.R.S.	Mulgrave Place.
1826	Bennett, J. N.	Windsor Villas.
1884	Bignell, George C., F.E.S.	7, Clarence Place, Stonehouse.
1888	Binns, Rev. W.	Caer Baden Terrace, Plymouth.
1888	Bourne, Gilbert C., M.A., F.L.S.	Marine Biological Laboratory.

LECTURING MEMBERS—*continued.*

Elected.	Name.	Address.
1861	Brent, Francis, F.S.A.	6, Tothill Avenue.
1885	Brenton, W. H.	8, Westbury Terrace, North Road.
1862	Briggs, Thomas Richard Archer, F.L.S.	Fursdon, Knackersknowle, near Plymouth.
1881	Burnard, Charles F.	Chatsworth Lodge, Compton Park Road.
1886	Burnard, Robert	3, Hillsborough, Mannamead.
1851	Cater, Samuel	North Devon Place.
1876	Chapman, Rev. Professor, LL.D., M.A.	Western College, Tavistock Road.
1880	Clarke, Sir Edward, Q.C., M.P.	Huntingdon Lodge, Peckham-rd., London.
1851	Collier, W. F.	Woodtown, Horrabridge.
1876	Collier, Miss Bertha Cycill	Woodtown, Horrabridge.
1876	Collier, Charles Calmady	Woodtown, Horrabridge.
1884	Collier, G. B., M.A.	Woodtown, Horrabridge.
1888	Cunningham, J. T., B.A., F.R.S.E.	Marine Biological Laboratory.
1882	Debnam, Alfred R.	10, Higher Portland Place, Stoke.
1884	Dickson, Rev. W., LL.D.	53, Haddington Road, Stoke.
1884	Dobell, Douglas D.	Notte Street.
1880	Edmonds, Robert G.	Mount Drake.
1882	Evans, H. Montague	4, South Devon Place.
1884	Evans, Godfrey	4, Rochester Terrace.
1874	Fouracre, John T.	Chapel Street, Stonehouse.
1875	Fox, Francis E., B.A., F.R.G.S.	Uplands, Tamerton Foliot.
1868	Fox, R. R.	Westbrook, Tamerton.
1851	Harper, T., M.R.C.S.	1, Gibbon Street.
1886	Harvey, T. H.	Cattedown.
1852	Hine, James, F.R.I.B.A.	Mulgrave Place.
1867	Hingston, C. Albert, M.D.	Sussex Terrace.
1875	Hughes, R. H., M.A., M.B., M.R.C.S.	12, Lockyer Street.
1876	Inglis, James C., C.E.	1, Buckland Terrace.
1881	Inskip, Capt. G., R.N., F.R.G.S.	Torrington House, North Road.
1868	Jackson, George, F.R.C.S.	Portland Square.
1851	Jago, George	Halwell House, Halwell Street.
1882	Jago, C. S., F.R.G.S.	Cobourg Street.
1883	Matthews, Coryndon, F.E.S.	Erme Wood, Ivybridge, S. Devon.
1874	Merrifield, John, LL.D., F.R.A.S., F.R.M.S.	7, Hobart Terrace.
1862	Mitchell, Philip, R.I.	Bedford Terrace.
1867	Monkswell, The Right Hon. Lord	7, Chelsea Embankment, London.
1870	Morley, The Right Hon. the Earl of	31, Princess Gardens, South Kensington, London, S.W.
1861	Mount Edgcumbe, The Right Hon. the Earl of	Mount Edgcumbe, Devonport.
1889	Murray, Robert	1, Windsor Terrace.
1884	Norman, John G.	Sea View Terrace.
1851	Oxland, R., PH.D., F.G.S.	Portland Square.
1871	Pearse, W. H., M.D.	1, Alfred Place.
1886	Phillips, Frank, F.R.C.I.	7, West Hoe Terrace.
1883	Prance, H. Penrose	7, Athenæum Terrace.
1859	Prowse, A. P.	Yannadon, Horrabridge.

LECTURING MEMBERS—*continued.*

Elected.	Name.	Address.
1884	Radford, Charles H.	37, Bedford Street.
1880	Rew, G. Gale	3, Whitefield Terrace.
1884	Rice, J.	21, Walker Terrace.
1875	Rider, A., F.C.S.	4, Haddington Road, Stoke.
1888	Ridge, B. J.	3, Gainsborough Place, Mutley.
1857	Risk, Rev. J. Erskine, M.A.	Princess Square.
1861	Rowe, J. Brooking, F.S.A., F.L.S.	Plympton.
1886	Sexton, Louis	Portland Square.
1860	Shelly, John	Princess Square.
1867	Slater, D., M.A.	Cheveley Hall, Seymour Road.
1886	Slater, Gilbert, B.A.	Cheveley Hall, Seymour Road.
1875	Smith, Robert	George Street.
1869	Square, W., F.R.C.S., F.R.G.S.	Portland Square.
1883	Square, William Joseph, F.R.C.S.	Portland Square.
1884	Square, J. Elliott, F.R.C.S.	Portland Square.
1865	Tweedy, W. Gage, B.A.	Athenæum Terrace.
1884	Vincent, Rev. Samuel	6, Woodland Terrace.
1885	Wade, William Cecil	5, Portland Square.
1883	Watson, G. F.	13, Smeaton Terrace.
1875	Webb, F. J., F.G.S.	13, Portland Villas.
1888	Weldon, W. F. R.	3, Windsor Terrace, Plymouth.
1887	Wilson, W. C., M.B.	St. Aubyn Street, Devonport.
1888	Wood, Carslake W.	Hareston, The Crescent, Plymouth.
1888	Wood, J. Winter	Hareston, The Crescent, Plymouth.
1873	Woollcombe, R. W., Surgeon-Major	St. Jean d'Acre Terrace, Stoke.
1879	Worth, R. N., F.G.S.	4, Seaton Road.
1878	Wright, W. H. K., F.R.H.S.	31, Headlands Park.
1885	Wyatt, R. C., B.A.	Fernhill, Mannamead.

"The property of the Institution, the election of members, management of the concerns, and enactment of laws, are vested exclusively in the Lecturing Members."—LAW 5.

ASSOCIATES.

Adams, Benjamin, Walmer Villa.
Allen, Mrs. E. R., 11, Coryton Terrace, Plymouth.

Barrett, G. R., Bank of England Place.
Barrett, J., 4, Seymour Terrace.
Barron, J., 16, Townsend Crescent, Compton Giffard.
Bayly, John, Seven Trees.
Bayly, Robert, Torr Grove, Plymouth.
Beechey, Admiral, 13, St. James's Terrace.
Berry, J. P., 2, Walker Terrace.
Brendon, W. Turner, George Street.
Brown, J. P., The Abbey, Plymouth.
Browning, F., Compton House, Compton.
Bulteel, Thomas, Radford, Plymouth.
Butler, Theobald, M.A., Wellington Villa, Mannamead.

Chalker, John P., 9, Crescent Place.
Clark, W., 19, Portland Villas.
Coath, Walter, Somerville, Thorn Park.
Cole, A., Bedford Terrace.
Collins, George, 4, Windsor Terrace, Plymouth.
Compton, C. E., 5, St. James's Terrace.
Cooper, Cornelius Francis, 17, East Street, Plymouth.
Cuming, Dr. C. H., Sussex Street.

Darton, William, Mount Batten.
Derry, W., Houndiscombe House.
Deutsch, Herr, 3, Hoe Park Place.

ASSOCIATES—*continued.*

Diment, Thomas, 8, Brunswick Terrace.
Dingle, Thomas, sen., 2, Channel View, Lipson Road.

Foale, William, jun., 3, Meadsfoot Terrace, Mannamead.
Foster, J. B., 4, Cambridge Street.

Greenlaw, Wm., 3, Glenside, Mannamead.

Harris, Henry Vigurs, Union Street.
Hawkins, George, The Cornish Bank, George Street.
Hearder, H. P., Westwell Street.
Heath, William, George Street.
Hill, F. N., 9, South Devon Place.
Honey, Augustine, Bank Street Chambers.
Hoskin, R., Ebrington Street, Plymouth.
Hubbard, G., J.P., Ford Park.

Jago-Trelawny, Major-General, Coldrenick, Cornwall.
James, Capt., R. W. Yacht Club.
James, C. H., Ingleside, Mannamead.
James, Edward, J.P., Greenbank.
Jasper, Thomas, 2, Melville Place, Ford.
Jenkins, Sir James, K.C.B., R.N., Nevingstone, Seymour Road, Compton Gifford, Plymouth.

Kerswell, Alfred J., Ham Street.
Kerswell, Samuel, 1, Osborne Place.
Kerswill, F. J., Frankfort Street.
King, William, Hoe House.

Lampen, Major-General, J., 6, Alton Terrace.
Latimer, Alfred, Portland Square.
Lemann, Fred. C., Blackfriars House.
Lemon, Rev. T. W., M.A., 1, Cheltenham Place.
Lovibond, J., H.M. Customs, Parade.

Mabin, Francis, 10, Union Street.
Martin, W., Windsor Villas.
MacAndrew, J., F.L.S., Lukesland, Ivybridge.
Mitchell, A., Rose Villa, Tavistock.
Mitchell, T., Eton Villas.
Morrish, F. A., 2, Bedford Terrace.
Morris, Charles, Gascoyne House.
Mugford, James A., 3, Leigham Villas.

Nicoll, G. B., 19, South Devon Place.
Norbury, Dr. H. F., R.N., C.B., Royal Naval Hospital.

Page, James A., 10, Windsor Terrace.
Pagen, J. Fletcher, F.G.S., Pendower, Mannamead.
Pearse, S., Royal Hotel.
Pearse, T., M.D., Flora Place.
Penrose, Richard A., 74, Durnford Street, Stonehouse.
Penrose, W. A., Victoria Chambers, Plymouth.
Penson, James, 7, Boon's Place.
Philips, G., 1, Victoria Place, Stonehouse.
Pode, J. Duke, J.P., Slade Hall, Ivybridge.
Preston, H., 3, Bedford Place.

Radford, John, Bedford Street.
Randle, J., Union Street.
Revelstoke, Lord, Membland.
Rodd, R. R., jun., 63, Union Street, Stonehouse.
Rooke, Samuel, 5, Westbury Terrace.
Rorie, John, M.D., Ford Park.
Roy, David, 6, Holyrood Place.

Serpell, E. W., 19, Hill Park Crescent.
Smith, E. S., Old Town Street.
Stephenson, G., Old Town Street.
Stephenson, R., National and Provincial Bank of England, Devonport.
St. Germans, The Right Hon. the Earl of, St. Germans, Cornwall.
Stribley, Edward, 3, Kobe Terrace.

Taylor, Frank, 37, Flora Street.
Taylor, J., 37, Flora Street.
Taylor, Sydney, 37, Flora Street.
Thomson, E. B., M.D., Norbiton House, North Road.
Trehane, J. H., Princess Square.

Underhay, Mrs. H., Billacombe, near Plymouth.

Wills, J. C., 68, Durnford Street, Stonehouse.
Wilson, J. Walter, 10, Leigham Villas.
Windeatt, John, Woodland House.
Wing, F. W., Lisson Grove, Plymouth.
Woodhouse, Henri B. S., 10, Portland Square.
Woollcombe, J. Y., Princess Square.

Yerbury, Major J. W., Mount Wise, Devonport.

LADY ASSOCIATES.

Bond, Miss Rosa A., Highfield, Hartley.
Borland, Mrs. R., Emma Place, Stonehouse.

Cann, Miss Agnes, 20, Tavistock Road.
Cooper, Miss Agnes G., 12, Cheltenham Place.
Creagh, Mrs. H. W., 4, Victoria Place, Stonehouse.

Gidley, Miss, 2, St. Michael's Terrace.

Keen, Miss, 1, St. James's Terrace.
Keen, Miss E., 1, St. James's Terrace.

Minhinnick, Miss E. M., Portland Square.
Murray, Miss F. E., 31, Portland Square.

Waghorn, Miss, 1, Seaton Terrace.

JUNIOR ASSOCIATES.

Crowther, J. B., 13, Buckland Terrace.
Worth, R. G. H., 4, Seaton Road.

BALANCE SHEET

OF

The Plymouth Institution and Devon and Cornwall Natural History Society,

FOR THE YEAR ENDING 1ST APRIL, 1889.

				1888		
	£	s.	d.	£	s.	d.
Annual Subscriptions	190	1	0	206	6	6
Arrears of ,,	5	5	0	1	1	0
Rent of Hall	13	1	8	8	18	6
,, Western Counties Telephone Co.	0	2	0	....		
Plymouth Art Club—Gas and Fires	0	5	0	3	8	8
Subscriptions to Museum Building	......			11	11	0
,, Museum Cases	......			4	0	0
Admissions to Museum	2	3	0	1	17	6
Sale of Transactions	0	8	0	8	12	6
Donation from Art Club	7	0	0	5	0	0
Sale of Birds	10	0	0	....		
Secretary—Balance Annual Excursion	0	11	9	....		
Balance	348	19	8	350	15	6
	£577	17	1	601	11	2

				1888		
	£	s.	d.	£	s.	d.
Balance	350	15	6	382	15	7
Lighting and Warming—Gas	12	6	11	11	8	9
,, ,, Fuel	2	6	6	3	16	0
Repairs, &c.	12	10	0	29	12	7
Taxes, Insurance, and Water	10	17	7	8	14	3
Museum and Art Gallery	2	11	0	....		
Library—Books, &c.	53	3	5	40	13	2
,, Binding	8	13	6	3	12	0
Reports	44	19	0	40	4	0
Stationery, Printing, &c.	6	6	3	8	6	3
Advertising	1	5	6	....		
Conversazioni	6	7	2	5	17	8
Salary and Commission	24	17	9	25	3	6
Petty Disbursements	16	17	4	16	15	9
Postages	4	6	5	4	7	9
Excursions	1	15	0	....		
Interest	17	18	3	20	3	11
	£577	17	1	601	11	2
Balance	348	19	8	350	15	6

We have examined the foregoing accounts and balance sheet, and compared the same with the vouchers, and find the same correct.

SAMUEL CATER, } *Treasurers.*
R. N. WORTH, }

LOUIS E. SEXTON, } *Auditors.*
JOHN G. NORMAN, }

April 4th, 1889.

REPORTS

PRESENTED AT THE ANNUAL MEETING OF MEMBERS,

4th April, 1889.

The Secretaries have much pleasure in presenting their Report for the year 1888–89, and in being able again to state that the operations of the Institution have been actively and satisfactorily conducted.

The programme of Lectures has been carried out without deviation. The attendances have on several occasions been considerably above the average, and some of the discussions have been exceptionally animated and interesting. It would, however, be very desirable that more Members and Associates should take part in this section of the Society's operations, for which ample opportunity is commonly afforded.

The Lectures delivered were:

1888.			
Oct.	4.	Conversazione.	
„	11.	President's Address.	
„	18.	The Dartmoor Volcano	Mr. R. N. Worth, F.G.S.
„	25.	Competition and Co-operation	Mr. J. C. Inglis, C.E.
Nov.	1.	The English Poor Law System	Mr. W. Adams.
„	8.	Atmospheric Electricity	Dr. Merrifield, F.R.A.S.
„	15.	Modern Theories in Chemistry	Mr. Louis Sexton.
„	22.	De Ruyter's Naval Operations Against England	Mr. W. Cecil Wade.
„	29.	Coral Reefs	Mr. G. T. Bourne, M.A., F.L.S.
Dec.	6.	The Influence of the Microscope on Modern Medicine	Mr. W. H. Brenton.
„	13.	Calderon as Poet and Dramatist	Miss A. G. Cooper.
„	20.	The Present State of Technical Education	Mr. C. S. Jago, F.R.G.S.

1889.		
Jan. 3.	Conversazione.	
„ 10.	The Mackerel Fishery . . .	Mr. B. J. Ridge.
„ 17.	The Making of the English Nation	Rev. W. Binns.
„ 24.	How to bring about the Millennium	Mr. Gilbert Slater, B.A.
„ 31.	Live Burial	Mr. W. J. Square, F.R.C.S.
Feb. 7.	Strings	Mr. Robert Smith.
„ 14.	The Eddystone: Facts and Fictions	Mr. H. B. S. Woodhouse.
„ 21.	Our Vernacular: Logical, Grammatical, and Grotesque . .	Mr. T. Winter-Wood.
„ 28.	Notes on the North-West Territories of Canada . . .	Mr. Richard A. Penrose.
Mar. 7.	The Poem of the Cid . . .	Rev. J. Erskine Risk, M.A.
„ 14.	The Shû King; or, The Oldest of the Sacred Books of China .	Rev. Samuel Vincent.
„ 21.	On the Track of the "Old Men," Dartmoor. No. II. . .	Mr. Robert Burnard.
„ 28.	The Blue Friars: A Notable Plymouth Brotherhood . .	Mr. W. H. K. Wright, F.R.H.S.

Mainly by death and removal there has been a slight decrease in the total number of Members and Associates. It is very desirable that the loss thus sustained should be made up as soon as possible. No local society covers so wide or so varied a field as the Plymouth Institution, or offers such advantages for the general pursuit of Science, Art, and Literature; and the Secretaries feel that an association which has for nearly eighty years been the chief centre of the intellectual life of the neighbourhood, and is now in the fullest activity, has the strongest claim upon all who are really interested in intellectual progress, whether for themselves or for the community at large.

The Treasurer's Statement shows a slight reduction in the debt, which now stands at £349. Various suggestions have been made for paying it off, but hitherto it has not been found possible to arrange for a special effort in a form which has approved itself to the Council.

The Anniversary Meeting was held on the 1st of May, when Mr. F. Brent exhibited several cases of local and typical flint arrowheads, and read a paper on the same, which gave rise to an interesting discussion. A paper was also read by Mr. R. N. Worth, F.G.S., on a Burial Urn from Cornwall.

The opening Conversazione of the season, on October 4th, had, as usual, for its leading attraction the fine collection of pictures forming the exhibition of the Plymouth Art Club. The musical arrangements were conducted by Mr. A. C. Faull, and songs were rendered by the Misses Bulley and Tregillus.

The second Conversazione, on January 3rd, had a scientific character. Mr. T. N. Andrew exhibited his admirable collection of electrical apparatus, and illustrated various electrical phenomena with the greatest success; Mr. F. G. Webb, F.G.S., worked his interesting harmonograph; and Mr. R. N. Worth exhibited a number of microscopic rock sections, local and typical. The musical programme was exceptionally successful, and Mrs. Hughes, Mrs. Harvey, Mrs. Lowell, the Misses Risk, Miss Watson, Miss T. Meeres, Mr. Collins, and Mr. Trounson, who rendered their various parts so successfully, deserve the thanks of the Society.

The Conversaziones at the commencement of each half of the Session continue to be appreciated by the Members and Associates, and of late have been exceedingly well attended.

The Secretaries beg to draw attention to the importance of keeping these social meetings up to a high standard of interest, and with that view take this opportunity of reminding Members and Associates that any assistance they can render will be appreciated, and will materially add to the usefulness of the Institution. The exhibition of articles of artistic, antiquarian, or scientific interest are specially welcome, while musical assistance is specially acceptable.

The question of adding to the opportunities of social intercourse has from time to time been mooted, and the Secretaries venture to express their opinion that this is a matter well worth the serious attention of the Council.

The Annual Excursion was to Liskeard and the Cheesewring district, July 4th. The party was large, the weather moderately favourable, and the arrangements excellent. The fine scenery and peculiarly interesting antiquities were equally enjoyed; the Trevethy Stone, the Hurlers, and the Cheesewring are prominent among the latter. Mr. F. Brent, F.S.A., kindly acted as antiquarian cicerone. The proceedings wound up with a very enjoyable high tea at Webb's Hotel, Liskeard.

There were two Afternoon Excursions. The first, a geological one, on June 6th, under the guidance of Mr. R. N. Worth, to the singularly interesting volcanic peak of Brent Tor, and to Lydford Gorge; the large party walking from Mary Tavy Station *viâ* Brent Tor to Lydford. The quaint little church on the Tor was visited by the kindness of the Rev. Mr. Smith, Mr. Worth making some remarks explanatory of its general history and features, while the Gorge was thrown open to the party by the courtesy of Mr. Daniel Radford. The weather was most propitious.

The second Excursion was antiquarian. Cothele Hall was visited on the 9th August, by the ready and courteous permission of the Earl of Mount Edgcumbe. The steamer *Prince* was hired for the occasion, and the party of over one hundred was the most numerous ever known in connection with the Institution. The attractions of the river scenery and the unique interest of the fine old historic mansion were thoroughly appreciated. The weather was again most favourable, and the party had a pleasant tea on board the vessel at Cothele Quay immediately before starting for the return.

There have been numerous additions to the Museum, which has had a good number of highly-interested visitors, and has further proved its value for study. As an instance of the utility of the Museum to Plymouth, about 2,000 visitors inspected it during the week of the Armada Tercentenary, and the caretaker advises that a steadily increasing number of the general public avail themselves of admission on free days.

Generally, the property of the Institution is in a satisfactory state of repair, and the hope expressed in previous reports, after our rather heavy exceptional expenditure on the building and its fittings, is being realized, and our expenditure returning to a normal condition.

The following shows the amount of debt for the years 1885–89: 1885, £520; 1886, £405; 1887, £382; 1888, £350; 1889, £349.

The Honorary Librarian reports:

The following works have been presented during the past year to the Library:

The Journal of the Royal Microscopical Society. Parts II.–VI. and VI.*a*, 1888; Part I., 1889. By the Society.

Proceedings of the Zoological Society of London. Part IV., 1887; Parts I.–III., 1888. By the Society.

Quarterly Journal of the Geological Society of London. Nos. 174–177 inclusive. By the Society.

Proceedings of the Royal Society of London. Nos. 264–277 inclusive. By the Society.

Proceedings of the Geologists' Association. Vol. X. (Nos. 5–8 inclusive). By the Association.

Proceedings of the Royal Geographical Society. Vol. X. (Nos. 5–12 inclusive); Vol. XI. (Nos. 1 and 2). By Mr. W. Square.

Belfast Naturalists' Field Club Annual Report, &c. Second Series. Vol. II., Part VII., 1886–87. By the Club.

Berwickshire Naturalists' Club Proceedings. Part II., 1886. By the Club.

Berwickshire Naturalists' Club Proceedings. Vol. X., Part III. By the Club.

Atti della Societa Toscana. Vols. VIII. and IX. Processi Verbali. Vol. VI. By the Society.

Transactions of the New York Academy of Science. Vol. VI., 1886–87. By the Society.

Transactions of the New York Academy of Science. Vol. VII., Nos. 1 and 2. By the Society.

Transactions of the New York Academy of Science. Vol. VII. (Parts I.–VII. inclusive). By the Society.

Transactions of the Royal Geological Society of Cornwall. Vol. II., Part II. By the Society.

Transactions of the Royal Geological Society of Cornwall. Vol. II., Part III. By the Society.

Report, &c., of the Manchester Scientific Students' Association for 1887. By the Association.

Somersetshire Archæological and Natural History Society's Proceedings. New Series. Vol. XIII. By the Society.

The Essex Naturalist. Vol. II. (Parts IV.–XII. inclusive). By the Essex Naturalists' Society.

Natural History Transactions of Northumberland, Durham, &c. Vol. IX., Part II. By the Society.

Notes on a Tract of Modified Ectoderm, by Alice Heath. By the Authoress.

Tourist's Guide to Gloucestershire, by R. N. Worth. By the Author.

Manchester Microscopical Society's Transactions and Annual Report for 1887. By the Society.

The Fifty-fifth Annual Report of the Royal Cornwall Polytechnic Society, 1887. By the Society.

Geological and Natural History Survey of Canada. Annual Report. Vol. II., for 1886, and Maps accompanying. By the Geological Survey of Canada.

Catalogue of Canadian Plants (Endogens), 1888. Part IV. By the Geological and Natural History Survey of Canada.

Mémoires du Comité Géologique. Vol. V., Parts II.–IV.; Vol. VI., Parts I. and II. Supplément des Bulletins du Comité Géologique for 1887. By the Society.

Penzance Natural History Society's Report and Transactions for 1887–88. By the Society.

Journal of the Marine Biological Association for August, 1888. No. 2. By the Association.

Proceedings of the Royal Dublin Society. Vol. V., Parts VII. and VIII.; Vol. VI., Parts I. and II. Transactions of the Royal Dublin Society. Vol. III., Second Series; Vol. IV., Second Series. By the Society.

Proceedings of the Bristol Naturalists' Society. Vol. V., Part III. By the Society.

Proceedings and Transactions of the Natural History Society of Glasgow. New Series. Vol. II., Part I. By the Society.

Proceedings of the Manchester Literary and Philosophical Society. Vol. XXXI. By the Society.

Journal of the Royal Geological Society of Ireland. New Series. Vol. VII., Part II. By the Society.

Report, &c., of the Devonshire Association for 1888. Vol. XX. By the Association.

Devonshire Domesday. Part V. By the Devonshire Association.

Journal of the Royal Institution of Cornwall, October, 1888. Vol. IX., Part III. By the Institution.

Smithsonian Report. Part II., for 1885. By the Smithsonian Institution.

Western States Geological Survey. Monograph 12: Geology and Mining Industry of Leadville, and Atlas accompanying. Emmons. By the United States Geological Survey.

Mineral Resources of the United States of America. Day. By the United States Geological Survey.

Bulletins for the United States Geological Survey. Nos. 40–47. By the United States Geological Survey.

Anales dei Museo Nacional Republica de Costa Rica. Toma I. By the Directors of the Museum.

Report of the Trustees of the Australian Museum for 1887. New South Wales. By the Trustees.

Journal of the Royal Society of New South Wales. Vol. XXI., for 1887. By the Society.

Prodomus of the Zoology of Victoria, New South Wales. Decade 16. McCoy. By the Premier of Victoria.

Prodomus of the Zoology of Victoria, New South Wales. Decade 17. McCoy. By the Premier of Victoria.

Journal and Proceedings of the Royal Society of New South Wales. Vol. XXII., Part I. By the Society.

Journal of the British and American Archæological Society of Rome. Vol. I., No. 4. By the Society.

Report of the Plymouth School Board from January, 1886, to January, 1889. By the Board.

Typical Illustrations of Lighthouse Work, by Chance Brothers & Co., 1869, f. 66. By Mr. S. Cater.

Transactions of the Northumberland, Durham, and Newcastle-on Tyne Natural History Society. Vol. X., Part I. By the Society.

Witnesses for Christ, and Memorials of Church Life, by Edward Backhouse. By Miss Backhouse.

Eskimo of Hudson's Strait, by F. F. Payne. 1889. By the Author.

The following have been purchased :

Challenger Reports. Vols. XXIII.–XXX.

Early English Text Society Publications. 87–92.

" " " Extra Series. 51–54.

Folk Lore Society Publications. No. 23 and Journal.

Zoological Record for 1887. Vol. XXIV.

Annals of Botany. Vol. II. and Nos. 5 and 6.

Coleoptera of British Islands. Matthews. Parts 16–27.

Palæontographical Society Publications. Vols. XLI. and XLII.

The following periodical Works have been continued :

Nature.

The Entomologist.

The Entomologist's Monthly Magazine.

The Zoologist.

The Philosophical Magazine.

Annals and Magazine of Natural History.

Geological Magazine.

Journal of Botany.

American Journal of Science.

Western Antiquary.

Ibis.

Mind.

Grevillea.

Quarterly Journal of Microscopical Science.

Journal of Anatomy and Physiology.

Annales des Sciences Naturelles —Zoologie.

The Curator of Fine Arts (Mr. Philip Mitchell, R.I.) reported that the past year had been marked by the acquisition of two important pictures for the Art Gallery. One, the portrait of an old and esteemed member of the Institution, Dr. J. N. Hearder, was presented by his son, Mr. W. Hearder. The other, a large and masterly work, given by Admiral Beechey, was painted by the generous donor himself. He is a Member of the Royal Hibernian Academy, and a frequent exhibitor at the Royal Academy. The picture represents the attack of Sir F. Drake on the Spanish Armada.

"Two of the pictures in the Gallery, portraits of Drake and Ralegh, were asked for, as a loan, by the Drake Tercentenary Committee. They were lent, and duly returned in good order.

"The frames of several of the pictures are much in want of repair, particularly that of a portrait of Sir W. S. Harris, from which large pieces are falling; it should be at once put into the gilder's hands."

The Curator then refers to proposals which have been made for the return of the Turner pictures now in the Art Gallery, a matter which is under the consideration of the Council. He says that he should deeply lament their removal, "as there is no other hall in the town where they can be placed. Though they may not be appreciated by the public, or all the members of this Institution, they are invaluable to the true students of art; they are intensely interesting examples of his work, as showing the dawning and the climax of the power of the greatest landscape painter this world has ever seen.

"The annual exhibition of the Plymouth Art Club was held in this Hall in August. The pictures were fewer in number, but of a much higher quality than usual. From the deficiency discovered at the close—the reasons for which are well known—it was found necessary to hold a supplementary exhibition. The results of this were so satisfactory, that we not only made good our losses, but were enabled to present the Institution with a donation of £7 as a mark of gratitude for the loan of the Hall.

"The annual conversazione, at the beginning of the winter session, was held whilst the pictures were still on the walls; and these, in addition to some good music, gave unqualified pleasure to a large company of the members and their friends."

The Curator of Anthropology, &c. (Mr. F. Brent) reported: "The collections in my charge are in good order; but no additions have been made thereto during the past year, either by gift or purchase."

The Curator of Osteology and Mammalia (Mr. F. H. Balkwill) reported that:

"During the past year another young Lesser Rorqual (*Balænoptera rostrata*) has been captured in our neighbourhood. On June 5th, 1888, the *Bluebell*, Captain Yewell, of Yarmouth, whilst fishing with drift-nets for mackerel, captured this young whale by its running its head through the bight of the warp. The whale made strenuous efforts to free itself; but a rope was passed round its tail, and the animal was hauled on board by the steam capstan. The place of capture was about twenty-five miles south of the Eddystone. The following are some of its dimensions: Female young Rorqual (*Balænoptera rostrata*). Weight, 30 cwt.; entire length, 18 ft.; length of gape, 3 ft. 9 in.; length from snout to commencement of dorsal fin, 10 ft. 6 in.; girth, 10 ft. The entire skeleton was secured for the Museum, where it will be placed as soon as it is mounted.

"I have also to record the addition of two very fine mounted specimens of hippopotamus' tusks; namely, a left-side lower canine, and a lower central incisor, of which the side to which it belongs is undeterminate. These very handsome and valuable specimens of ivory were added to your collection, through the instrumentality of Mr. Worth, at the nominal cost to the Institution of ten shillings."

The Curator of Ornithology (Mr. H. M. Evans) reported: "No contributions have been made during 1888–9. The collections have suffered very little from the attacks of insects. The number of birds being too great for display in the present cases, and it being found that the Society had (in acquiring at various times from different collectors) become possessed of many duplicates, the law providing for disposal of surplus specimens has been brought into operation, under the sanction of the Council, and 115 birds sold very advantageously. I hope, if re-appointed, to proceed, now there is more space, with the long-needed arrangement of the 800 specimens in my charge. The collection of eggs remains unaltered since my last report."

The Curator of Botany (Mr. D. D. Dobell) reported the receipt during the year of a second donation of specimens of plants from Mr. T. R. Archer Briggs, F.L.S., representative of 115 species, 44 of which were not hitherto represented in the Athenæum. All these, retaining the old labels, he has had mounted, and placed in order. 644 species of local plants now exist in the Institution's Herbarium, arranged on the Natural System, and according to the London Catalogue. He adds:

"When the study of Biology shall have farther progressed in Plymouth a botanical garden will become a necessity, and afford that information about plant-life which no dead and dried plants can possibly yield."

The Curator of Geology (Mr. F. J. Webb) reported: "During the past year the collection has received important and valuable additions by gifts from Lieut. Lyons, R.E. They consist of (1) a series of Silurian fossils from the Clinton Beds of Canada; (2) a series from the Carboniferous Limestone of Ireland; (3) a series of Jurassic (Middle Oolite) illustrating the Coral Rag of Faringdon; (4) miscellaneous, from Upper Oolite, Cretaceous, and Woolwich and Reading Beds of the Eocene."

The Curator of Petrology (Mr. R. N. Worth) reported: "A number of additions, chiefly local, but including a few typical, have been made to the collection under my charge.

"The most important is a full series of examples from a very ancient detrital deposit discovered by Mr. R. Burnard on the northern slope of Cattedown, 60 to 70 feet above datum; and at a depth of from 3 to 5 feet. It consisted of pebbles and subangular stones—ranging from 3½ lbs. in weight to a quarter ounce or less—scattered through undisturbed clayey subsoil immediately overlying the limestone. With a few exceptions, though these are important, the rocks are those still found in Devon; but the peculiarity of the deposit is that the great majority of the rocks represented do not occur *in situ* in the watersheds of the Plym and Tavy, or of either of the rivers of South-West Devon, so that an enormous change in the physical conditions of the county is indicated — Carboniferous, Triassic, Liassic, and Cretaceous rocks formerly existing within the area having disappeared, with the exception of such fragmentary vestiges as those under consideration.

"A numerical census shows that flints of various kinds formed 40 per cent. of the deposit; schorl rock, 13 per cent.; limestones, 10 per cent.; grits and quartzites, 10 per cent., the grits being to the quartzites as two to one; quartz pebbles, 9 per cent.; slate, 2 per cent.; chert, 2 per cent.; lydian stone, quartz schist, and hornblende schist, each one example. All these rocks occur in the county. The limestones include a Liassic, a Cretaceous, and a cherty Carboniferous pebble—the nearest existing points for the two former being the east of Devon, and for the third the north of Dartmoor.

"Rocks of direct igneous origin muster 13 per cent. There are six examples of granitoid rocks (elvans, pegmatite, and schorlaceous granite, but not one a typical granite); Devonian lavas; diabase, resembling that of Estover; gabbro or epidiorite; and Triassic trap—all at present represented in the district.

"The other rocks of the igneous series are wholly new to us in Devon. First in importance are two examples of typical andesite—one a hypersthene-andesite, and the other an augite-andesite, closely resembling the rocks of the Andes; and then we have a red-brown volcanic conglomerate, mainly composed of andesitic fragments, suggested by Professor Bonney to be the result of the denudation of volcanic cones; and several examples of greatly altered volcanic breccias or tuffs, now highly siliceous green pebbles. The rocks of this last group might well have come from the long-vanished volcanic superstructure of Dartmoor, and indeed there is no other local source to which they can be assigned.

"The presumption that they did so is strengthened by the important fact that during the past year your Curator has found distinct volcanic rocks on Dartmoor, with a volcanic breccia at Lee Moor, which includes rock fragments of the same andesitic type, and shows flow-structure in a felsitic matrix."

J. C. INGLIS. } *Hon. Secs.*
H. PENROSE PRANCE, }

METEOROLOGICAL REPORT.

SUNSHINE IN PLYMOUTH FOR 1888.

MONTH.	Sun above the horizon		Sun shone in Plymouth		Percentage actual was of possible.	No. of days no sunshine.
	hrs.	min.	hrs.	min.		
January	259	25	50	23	19·4	17
February	286	58	88	50	31·0	5
March	364	46	97	32	26·8	6
April	409	56	131	58	32·2	6
May	474	9	240	37	50·7	3
June	484	6	163	12	33·7	3
July	486	31	151	58	31·2	7
August	441	24	171	37	38·8	5
September	372	22	172	26	46·3	6
October	325	50	115	47	35·5	8
November	263	47	43	36	16·5	13
December	244	11	70	5	28·7	12

The sunshine for the year was nearly 34 per cent. of that possible, or he shone in Plymouth for rather more than one-third of the time he was above the horizon, while on 91 days he was not visible here.

RAINFALL.—Rain fell on 192 days to the amount of 37 inches, which is below the mean, but the greatest rainfall since 1882. The heaviest rainfall for the year in twenty-four hours was 1·21 inches, on the 4th November. For six months of the year the rainfall was below the average, February and September being the dryest months. The wettest months were July and November. On one day only was there measured more than an inch of rain. The longest dry period was from 18th February to 8th March, during which time only ·08 inch fell; and from 5th to 27th September, during which time only ·04 inch fell. The longest wet period was from 13th July to 2nd August, during which time there was no perfectly dry day; and in the forty-two days from 28th October to 8th December there were only seven dry days, and 10·78 inches fell during the time.

Wet Months.—March, May, June, July, August, November.

Dry Months.—January, February, April, September, October, December.

Barometric Pressure.—The greatest atmospheric pressure was 30·718 inches on 9th January; the least was 28·474 on 29th March. Thus the greatest range was 2·244 inches, whilst the average range was 1·077 inches.

Temperature.—The temperature for the year was 49·18 degrees F., or 1¼ degrees F. below the mean, owing to a lower mean day temperature. February, March, April, and July were very cold; while November and December were hot. The highest temperature in the screen was 76·8 degrees F. on 2nd June; the lowest was 23·0 degrees F. on 25th February. The annual range was thus 53·8 degrees F. in the screen. The hottest day in the sun was 139·0 degrees F. on 30th July, and the coldest on the grass 19·0 degrees F. on 29th January, giving as the maximum annual range 120 degrees F.

Hot Months.—May, November, and December.

Cold Months.—January, February, March, April, June, July, August, September, and October. The effect of such a cold, wet summer was found in the bad supply of (unripe) fruit.

Winds.—The number of mornings on which easterly winds have prevailed has been far in excess of the average, and there has also been a greater number of calm mornings; yet there has been an average rainfall, owing to the heavy showers, which were particularly conspicuous in July and November.

Gales were experienced on 16th January, 10th and 11th March, of great violence, and 27th November, also very heavy.

Snow fell on eleven days; viz., one in January, four in February, and three each in March and April.

Hail fell in March, and heavy in November.

Thunderstorms were experienced on 24th June, 13th July, 1st August, and 26th and 27th November.

J. MERRIFIELD.

An ABSTRACT from the METEOROLOGICAL REGISTER, from 1st January, 1888, to 31st December, 1888, kept at No. 7, Hobart Terrace, Lipson Road, Plymouth (Lat. 50° 22½′ N., Long. 4° 7′ W.), by JOHN MERRIFIELD, LL.D., F.R.A.S., F.R.M.S.

MONTH.	BAROMETRICAL PRESSURE REDUCED TO MEAN SEA LEVEL AT 32° FAH.			TEMPERATURE.			HYGROMETER.				RAINFALL.		DIRECTION OF WIND AT 9 A.M.				
	Average Barometer	Maximum for Month.	Minimum for Month.	Average Maximum in shade.	Average Minimum.	Average temperature.	Average dry Bulb.	Average wet Bulb.	Average dew Point.	Average humidity, Saturation, 100.	No. of days on which not less than ·01in. fell	Quantity for the month in Inches.	From N. by E. to E.	From E. by S. to S.	From S. by W. to W.	From W. by N. to N.	Calm.
1888																	
January .	30·253	30·718	29 217	45·34	36·05	40·70	40·05	39·23	38·07	90	18	2 29	5	11	3	4	8
February .	30·032	30·408	29·518	41·79	32·61	37·20	36·03	35·39	34·43	94	10	·80	12	1	1	5	10
March . .	29·635	30·240	28·518	45·95	34·61	40·28	39·55	38·10	36·21	88	19	4·71	8	3	8	7	5
April . .	29·921	30·276	29·532	51·66	39·90	45·78	45·07	42·77	40·12	83	12	1·16	6	10	5	7	2
May . .	30·057	30·471	29·387	61·32	46·74	54·03	53·62	49·78	45·94	75	10	2·19	1	19	5	4	2
June . .	29·939	30·252	29·611	65·40	52.37	58·89	58·37	55·20	52·35	80	16	2·74	2	20	1	6	1
July . .	29·782	30·206	29·440	65·30	53·77	59·54	58·72	56·35	54·22	86	24	5·11	2	11	8	9	1
August . .	30·032	30·313	29·593	65·36	54·20	59·78	59·39	56·80	54·47	85	17	3·25	3	14	8	4	2
September.	30 170	30·479	29·812	63·76	50·44	57·10	56·96	54·47	52·23	85	9	1·02	12	8	3	3	4
October .	30·081	30·394	29·332	55·88	44·44	50·16	49·33	47·81	46·14	89	14	1·99	7	9	3	4	8
November.	29·786	30·376	29·164	53·61	45·19	49·40	48·80	47·88	46·88	94	24	8 21	4	9	9	5	3
December .	9·946	30·513	28·982	49·91	39·68	44·80	44·29	43·50	42·63	94	19	3·43	2	11	9	5	4
Average for 1888	29·970	30·387	29·342	55·44	44·17	49.81	49·18	47·27	45·31	87	192	36 90	64	126	63	63	50
Average for 24 Years . .	29·953	30·410	29·333	57·63	44·84	51·24	50.41	48·48	46·60	87	185·9	36·08	78·7	64·2	100·	81·0	41·1

The observations are all made at nine a.m. The Rain Gauge is by Casella, and 8 inches in diameter; its top is 9 feet 2 inches above the ground, and 131·2 feet above the mean level of the sea. A rainy day is one in which not less than 1-100th of an inch falls. The instruments have all been supplied by the Meteorological Committee of the Royal Society, compared at Kew, and the index error supplied to each.

TRANSACTIONS

OF THE

PLYMOUTH INSTITUTION

AND

Devon and Cornwall Natural History Society.

1888–89.

ADDRESS

AT THE OPENING OF THE SESSION 1888-9.

BY GEORGE JACKSON, F.R.C.S.Eng.,

President.

Ladies and Gentlemen,—

Having been chosen as President of this Institution, it is my duty to deliver an introductory address; and in doing so, I shall endeavour to bear in mind the twofold character of this Society. It is a Literary Institution, and it is also a Natural History Society. It has been established now for some seventy-six years, and has assembled in this building since 1819.

I fear that in some respects the present age is not so favourable to institutions such as this as those which have passed away. Persons are very apt to say, "What is the use of attending this or that lecture? I can read it all in the papers to-morrow;" or, "I know all about it." And again, others, who may have had superior advantages to us poor provincials, think no good thing can come out of Nazareth, and that only at Jerusalem (London) can any good thing be found. I maintain, however, that societies such as this have their use in eliciting the various opinions which may be held on the subject under discussion. It is well known that by striking even flint stones together some scintillations of light may be made to appear.

Another charge I have to bring against the present age is the exceeding hurry and bustle of life, which leaves but little time for calm reflection. This appears to be especially true in the case of men who have embarked in the stormy sea of politics. No sooner is the Parliamentary session at an end than political speeches have to be made in the country. In fact, to use the language of

Commerce, the exports exceed the imports, and impoverishment of the mental soil is the consequence.

There is another important branch of this Institution which is not sufficiently known, and which is comparatively unused. I refer to the Museum. Since its enlargement and re-arrangement it is well worthy of attention. It is painful to see the listless way in which the majority of persons walk through a museum, as though it were a something which had to be done but which there was no pleasure in doing. Doubtless more might be done to make our Museum more attractive. We might have cases, such as are to be found in the National History Museum at South Kensington, illustrative of the various points which have been treated and elucidated by the illustrious Darwin.

In the entrance-hall of that museum, which serves as a key-museum to the other parts, there are cases illustrative of the doctrine of Natural Selection. One especially struck me as being exceedingly good. It contained thirty different varieties of pigeons, which have been all created, so to speak, by Natural Selection from one—the wild rock pigeon. The contrast between some of them, such as the fantail and pouter, or the short-faced Antwerp pigeon, is very marked. In the latter the anatomical structure of the skull must be much changed. Gradation in ornament is well exemplified by specimens showing how the peacock's feathers commence with a very simple form, and gradually work up to the gorgeous eye-bearing feather—beginning with dark and light bands having no metallic lustre, and again shading off into the curiously modified feathers which complete the margins of the tail. Darwin says cases of gradation are important, as they show that it is at least possible that highly complex ornaments have been acquired by small successive steps. I much wish our Museum could be made more interesting and instructive in the way I have indicated, and by having descriptive catalogues published at a low price. I refer to this matter that some may be fired with enthusiasm in the cause, and may be induced to help us either by labour or by money, which is equally wanted to carry out the things I have referred to.

We want a little of the enthusiasm of Mr. Thomas Hawkins, who in his work on *Great Sea Dragons* thus describes the discovery of the *Chiroligostinus*, a species of Ichthyosaurus, at Lyme Regis. He says, "Who can describe my transport at the sight of the colossus? My eyes the first which beheld it. Who shall ever see them lit up with the same unmitigated enthusiasm again? The heat, did I say? yea, the heat of the blessed sun; for by that was dried up against the brick walls of my workshop the acacian gum with which I succeeded in reintegrating it."

Then again, in describing the find of the Ichthyosaurian *Chiropolyostinus*, and speaking of its extremities, he writes, "No words can express my sense of these two paddles" (the fore and hind limbs are converted into swimming paddles). "What a multitude of pentameters belong to these ossicular strings, every one of them worth a necklace of oriental pearls. These paddles are exquisitely beautiful—they are Nature's own mosaic."

Perhaps all this is too much in the style of Buffon—too general, and not sufficiently accurate and descriptive for the present race of naturalists. Still it shows the enthusiasm of the man and the interest he took in the pursuit of Natural Science. It appears that he was a man of considerable property, so that his work was done entirely for the love of science. His collection of Icthyosauri, *et hoc genus omne*, are now in the Natural History Museum at South Kensington, where his book on the *Great Sea Dragons*, as he calls them, may be consulted.

He was very much annoyed by the way in which fine specimens were often destroyed by quarrymen and others. He thus describes a colloquy between two quarrymen over the *Triatarsostinus*, a portion of which he rescued from their destroying grasp:

"Quarryman No. One says, 'I wonder what 't is? A viery dragenn, a maa be.'

"Quarryman No. Two, 'One that stinged Moses, a maa be. Here 's at 'un!'" And so they smashed it.

The enthusiasm and the perseverance of such men as Mr. Hawkins, although not much known to general fame, is well worthy of being emulated.

I often think that in the race after something new, the desire to learn or know some new thing, we are very apt to forget what has been done by men who have laid the very foundation-stones of our present knowledge. Take, for example, such a man as Descartes. I suspect that there are but few of the fairly well-informed people of the present time who have anything but a vague idea of his work. Yet there is no doubt that, next perhaps to our own Newton, he laid the foundation of much of our modern Knowledge and Science—more especially in Mechanics and Optics. He first pointed out the laws which govern the refraction of Light in passing from one medium to another, and explained the rainbow colours; and he very nearly arrived at the explanation, which Newton afterwards made, of the structure of Light. I pass around a portrait of him, made in 1644, the year in which he wrote his Meditations. The inscription states that he was borne at La Haye, in the province of Touraine, on the last day of March, 1596, and styles him "Lord of Perron"—Perron being the name of a small estate he inherited from his mother. So far as one can judge from the portrait, it would indicate that he was a man of a somewhat sarcastic and cynical turn of mind. After receiving as good an education as the times would permit, at the Jesuit College of La Flèche, he went to Paris, where he studied for four years in great seclusion. At the age of twenty-one he entered the army, joining the troops of Prince Maurice of Nassau in Holland, his motive being the desire of seeing men and the world. He travelled over the best part of the civilised world, and finally settled at Amsterdam, in 1629, at the age of thirty-three years—Holland being then the land of freedom, civil and literary. He also preferred the cooler atmosphere of the Low Countries to the heat of Italy and France. In the former he could think with cool head; in the latter he could only produce phantasies of the brain.

Here he wrote his celebrated *Discourse on Method;* and Saisset has well said, "It ought not to be forgotten that in publishing the *Method* Descartes joined to it, as a supplement, the Dioptrics, the Geometry, and the Meteors. Thus at one stroke he founded, on the basis of a new method, two sciences hitherto almost unknown and of infinite importance—Mathematical Physics and the application of Algebra to Geometry; and at the same time he gave the Prelude to the Meditations and the Principles—that is to say, to an original Metaphysic, and the Mechanical Theory of the Universe." The publication of the *Method* brought on the enmity of Voët, a Protestant clergyman at Utrecht, who accused Descartes of Atheism. Voët, with Schook, of Groningen, tried to get the magistrates to condemn him as an atheist and calumniator—as atheist, apparently because he had given new proofs of the existence of God; as calumniator, because he had repelled the calumnies of his enemies.

However, the Ambassador of France and the Prince of Orange stopped the proceedings. Subsequently Descartes went to Stockholm to reside, at the request of Queen Christian, daughter of the great Gustavus Adolphus. Unfortunately this lady insisted on having lectures on Philosophy in the winter time at 5 a.m. This was too much for Descartes. He took cold and died of pneumonia, at the age of fifty-four. His remains were subsequently brought to Paris, and there was to have been a funeral oration pronounced; but this was stopped by an order from the court, obtained by Father Le Tellier.

Huxley says, "Descartes lived and died a good Catholic, and prided himself upon having demonstrated the existence of God and of the soul of man. As a reward for his exertions, his old friends, the Jesuits, put his works on the *Index*, and called him an atheist; while the Protestants of Holland declared him to be both a Jesuit and an atheist. His books narrowly escaped being burned by the hangman; the fate of Vanini was dangled before his eyes; and the misfortunes of Galileo so alarmed him that he well-nigh renounced the pursuits by which the world has so greatly benefited, and was driven into evasions and subterfuges unworthy of him."

In his *Discourse on Method* Descartes lays down certain rules for himself.

The *first* was: "Never to accept anything for true which I did not clearly know to be such; that is to say, carefully to avoid precipitancy and prejudice, and comprise nothing more in my judgment than what was presented to my mind so clearly and distinctly as to exclude all ground of doubt." In fact, he may be said to have consecrated Doubt, and to have been the progenitor of Philosophic Doubt.

The *second:* "To divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution."

The *third:* "To conduct my thoughts in such order that, by commencing with objects the simplest and easiest to know, I might ascend by little and little, as it were step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which in their own nature do not stand in a relation of antecedence and sequence."

And the *last:* "In every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted."

Descartes may be said to have so used the Deductive form of reasoning rather than the Inductive. Bacon proposed from effects to infer the cause. Descartes, although he does not reject experiment and observation, says: "We employ experiment, but not as a reason by which anything is proved; for we wish to deduce effects from their causes, and not causes from their effects. We appeal to experience only, in order that we may be able, out of the innumerable effects which may be produced by the same cause, to direct our attention to one rather than the other."

"As it is not enough," he says, "before commencing to rebuild the house in which we live, that it be pulled down and materials and builders provided, but we must have some temporary place of accommodation during the operation;" so he lays down for himself a provisory code of morals, consisting of three principal maxims:

"The first was to obey the laws and customs of any country, adhering firmly to the faith in which, by the grace of God, I had been educated from my childhood, and regulating my conduct in every other matter, according to the most moderate opinion and the farthest removed from extremes, which should happen to be adopted in practice with general consent of the most judicious of those among whom I might be living." He adds, "I ought rather to take cognizance of what they practised than of what they said, not only because in the corruption of our manners are few disposed to speak exactly as they believe, but also because very many are not aware of what it is they really believe; for as the act of mind by which a thing is believed is different from that by which we know that we believe it, the one act is often found without the other." Probably he refers here to the fear men were under in expressing their real opinions on some subjects, such as religion, owing to the persecution which was prevalent at that time. He wisely also observes that "it is better to adopt moderate opinions rather than extreme ones, as in the event of falling into error I might be at a less distance from the truth than if, having chosen one of the extremes, it should turn out to be the other I should have adopted." He evidently believed in the old Latin proverb—"*In medias res tutissima via.*"

The second maxim was: "To be as firm and resolute in my actions as I was able, and not to adhere less steadfastly to the most doubtful opinions when once adopted than if they had been highly certain. This principle of adhering to a line of action when once adopted was sufficient thenceforward to rid me of those repentings and pangs of remorse that usually disturb the consciences of such feeble and uncertain minds as are destitute of any clear and determinate principle of choice, and allow themselves one day to adopt a course of action as the best, which they abandon the next as the opposite."

His third maxim, he continues, was: "To endeavour always to conquer myself rather than fortune, and change my desires rather than the order of the world, and in general accustom myself to the persuasion that, except our own thoughts, there is nothing absolutely in our power. This single principle seemed to me sufficient to prevent me from desiring for the future anything I could not obtain, and thus render me contented."

He admits, however, that prolonged discipline and frequently-repeated meditation is necessary to accustom the mind to view all objects in this light. He believed that in this consisted chiefly the power of the old philosophers, who were enabled to rise superior to the influence of fortune, and, amid suffering and poverty, enjoy a happiness their gods might have envied. He evidently agreed with the writer of the verse—

"Stone walls do not a prison make,
Nor iron bars a cage."

Having provided himself with these maxims, and having placed them in reserve along with the truths of faith, he considered that he might with freedom set about ridding himself of what remained of his opinions. And to this end he travelled for nine years, desirous of being a spectator rather than an actor in the plays exhibited on the theatre of the world. By reflecting particularly on what might be doubted, he says that he gradually rooted out of his mind all the errors which had hitherto crept into it. Not, he says, that he imitated the Sceptics, who doubt only that they may doubt, and seek nothing beyond uncertainty itself; for, on the contrary, his design was simply to find ground of assurance, and cast aside the loose earth and sand that he might reach the rock or the clay.

Descartes certainly appears to have fallen into error when he tries to argue that men alone possess reason and that brutes have none, mainly on the ground that animals, although in some instances able to utter words, yet do not understand them, and are incapable of carrying on a conversation. He imagines that since they are endowed with many organs analogous to ours, they could as easily communicate their thoughts to us as to their fellows; but he apparently does not attempt to draw any distinction between instinct and reason. I should imagine from this that he had not paid much attention to the habits of animals, more especially such animals as dogs, whose acts are undoubtedly guided by reason in many instances.

He advocated a practical rather than a speculative Philosophy, and considered that by studying the laws of physics we might be able to turn the forces of Nature to greater uses, and so render ourselves the lords and possessors of Nature, thus anticipating many of the discoveries which have since been made, such as the uses of steam, electricity, and the like.

Thus he says, "This is a result to be desired, not only in order to the invention of an infinity of arts by which we might be enabled to enjoy without any trouble the fruits of the earth and all its comforts, but also and especially for the preservation of health, which is without doubt, of all the blessings of this life, the first and fundamental one; for the mind is so intimately dependent upon the condition and relation of the organs of the body, that if any means can ever be found to render men wiser and more ingenious than hitherto, I believe that it is in medicine they must be sought for." He thought that if we had such ample knowledge of the causes of the diseases which afflict us, and of the remedies provided by Nature, we could free ourselves from an infinity of maladies of body as well as of mind, perhaps also from the debility of age. In his time very little was known of the true causes of diseases, and very little, except empirically, of the remedies for them.

It has been said that all the thoughts of men, from the beginning of the world until now, are linked together into one great chain. Huxley says that the thoughts of men seem rather comparable to the leaves, flowers, and fruit upon the innumerable branches of a few great stems, fed by commingled and hidden roots, and that these stems bear the names of a few men endowed with intellects of heroic force and clearness. So that, no matter what point in the world of thought is taken up, the history of it is sure to bring us back to one of these central stems. He thinks that Descartes is the thinker above all others who stands in this relation towards the Science and Philosophy of the modern world; that in any characteristic product of the modern ways of thinking you will find the spirit of that thought, if not its form, to have been present in the mind of the great Frenchman.

Descartes, living as he did about the time of the celebrated Harvey, was acquainted with his researches into the method of the circulation of the blood, and was evidently much impressed thereby, as he describes it more than once in his works, and he adopts a physico-mechanical view of the way in which the functions common to man and animals are performed. He looked on consciousness as the peculiar distinction of the *chose pensante* of the rational soul, which in man—and in man only according to Descartes—is superadded to the body.

He thought this rational soul to be lodged in the pineal gland—a small structure at the base of the brain—as a sort of central office, and that here, by the intermediation of the animal spirits, it became aware of what was going on in the body, or influenced the operations of the body. Matter, according to Descartes, is substance which has extension, but does not think; spirit is substance which thinks, but has no extension. He said, *Cogito, ergo sum*, "I think, therefore I am." Thought, then, is Existence.

Huxley, although criticising this assertion, says that the method or path which leads to truth, indicated by Descartes, takes us straight to the Critical Idealism of his great successor Kant. It is that Idealism which declares the ultimate fact of all knowledge to be consciousness, or, in other words, a mental phenomenon, and therefore affirms the highest of all certainties—and indeed the only absolute certainty—to be existence of mind. Bouillier says that Descartes has merited the title of the father of physics as well as that of the father of modern metaphysics.

Doubtless all present have heard, more or less vaguely, of the wonderful microbes, spores, bacteria, and the like, which surround us on every hand. Although it has long been suspected that many diseases were due to the presence of minute forms of life, which multiplied very rapidly, still until quite recently no proof had been forthcoming. The investigations of Tyndall into the existence of germs in the air, which undoubtedly are the causes of putrefactive and other changes, and the efforts of Lister to exclude those germs from wounds, and to render them innocuous, called attention to the subject in a marked manner. More recently the enquiries of Professor Koch into the bacillus—the so-called comma bacillus—of cholera, have given rise to a great deal of discussion; it being argued by some that the bacillus found by Professor Koch is harmless, and is found naturally in the saliva. Doubtless in many cases the microbes are simply present, but are not the cause of the disease. The only way to ascertain this is by what is called cultivation. The suspected bacteria, micrococci, and the like, are cultivated in a suitable medium, proper precautions being taken to avoid the introduction of foreign germs. The experiment is then tried as to whether the cultivated germs will reproduce the disease when introduced into the system of an animal. By the so-called attenuation of these germs a milder form of the disease is produced, and so the system can be rendered proof against the specific disease of which the germs have been so treated.

Thus with regard to the plan adopted by Pasteur to prevent anthrax—malignant carbuncle. The bacilli, or rod-like bodies of anthrax, sometimes contain spores, which have an extraordinary vitality, and are intensely virulent.

Tyndall found that by a process of discontinuous heating he could kill them. The spores in the intervals between the heatings sprout into rods, and these perish at the next boiling before they have time to develop spores. After three or four heatings all vitality has been destroyed.

Pasteur takes this microbe in the rod stage of its development, and keeps it in a temperature which favours its existence, and even its multiplication by division, but which is not sufficient to further favour the development of spores. At a temperature of 42° or 43° C. the microbe produces no spores. Therefore, in contact with pure air, he could maintain a culture deprived of all spores. In some weeks the crop dies; for being rendered sporeless by this enforced method of development, it is easily destroyed; but by favouring conditions it can be revived prior to its extinction. Then with this attenuated anthrax microbe Pasteur vaccinates sheep, horses, and oxen, and makes them proof against the disease itself. In 1883 500,000 of these animals were vaccinated.

Bacteria are now considered to belong to the vegetable kingdom, being able to derive nourishment from ammonia compounds. They differ from the higher vegetable cells in being unable to split up carbonic acid into its elements. This is said to be due to their not possessing chlorophyl, or green colouring matter. Bacteria may be defined as minute vegetable cells devoid of nuclei; the cell-walls consist of cellulose, the contents being protoplasm, which varies in its constitution, as shown by the different manner in which chemical agents for staining them act. In some instances they contain starch granules, and then of course they will stain a dark colour with iodine. Others contain sulphur granules, and in others again certain colouring matters.

Bacteria differ in shape. Sometimes they appear as micrococci, or round or egg-shaped cells. These increase by fission, or division; sometimes the two divisions remain attached at one end, and then you have a diptococcus. These may again divide; so that you may get a string of them, when they are streptococci. Division may take place in two or three directions, so that four or eight cells may result from the division of one.

Bacilli are rod-shaped bodies; when short called bacteria, when long bacilli; when bent, they are called vibriones. Sometimes they have a corkscrew form, and are called spirilli. Under the microscope some appear to be endowed with locomotive powers, and others are motionless. They can be readily observed in any vegetable infusion which has putrefied. It is considered by some that the movements are only molecular, and are not independent. Undoubtedly some move by contraction of their protoplasm, as they have a filamentous termination, which lashes about freely. As before mentioned, their multiplication may take place by fission, or division, or by spores, as in anthrax bacillus. Some bacteria require oxygen, and others can derive their nourishment from oxygenised compounds in the medium in which they grow. Pasteur on this account divides them into aerolic and anaerolic. They require nitrogen to build up their protoplasm, and carbon also; water is likewise necessary. A practical proof of this is found in the preservative qualities of sugar, the addition of which to preserved fruit prevents the formation of fungoid growths by absorbing the water.

In order to cultivate the various forms of microbes, very various media are required; some thriving in one medium, and not in another. Sometimes liquid media are used, as chicken broth, beef tea, &c.; and at others solid media, such as potatoes cut open with a sterilised knife, or nutrient jelly, made frequently of beef juice, and salt and peptone—*i.e.* albumen, acted on by the gastric juice—thickened with agar-agar (Ceylon moss). All the glass vessels, test tubes, &c., are carefully cleansed and sterilised by heat, lest some germ other than that which it is desired to cultivate should be introduced into the cultivating medium. After being cleansed and stoppered with a plug of cotton wool, they are placed in the hot-air chamber at 150° C. for an hour, which destroys any germs in the vessels or cotton wool. As the jelly may be contaminated in being poured into the test tubes, this process must be repeated after the jelly has been placed in the tubes. For this purpose they are placed in a steaming apparatus for fifteen minutes, and this is repeated for three or four successive days. To inoculate with the germs which it is wished to cultivate, a needle of platinum wire is used, fixed at the end of a glass rod. Platinum wire does not retain heat, so it can be sterilised by being passed through a flame quickly and then used at once. The cotton plug is removed, and the wire, charged with the substance to be examined, is traced on the surface of the cultivating medium, and so the germ is sown, so to speak.

By the way in which the germ grows the nature of it is recognisable; some forms spreading downwards, and others laterally. A form called *Proteus vulgaris*, which is sometimes found in the matter of an abscess, grows rapidly in nutrient jelly, liquefying it. If grown in meat infusion, small oval bodies will predominate; but if in nutrient jelly, on a sterilised glass plate, if examined within a few hours of inoculation, a different appearance will be found. Growth appears along the track of the needle, and quickly spreads over the jelly. In a few hours small transparent colonies are seen on the surface, and these, when examined microscopically, are found to consist of large bacilli, or rod-shaped bodies. As these colonies get older they become denser in the centre, and the bacilli shorter; while at the circumference very long threads are seen projecting outwards into the gelatine. After a time it will be found that the line of the needle is quite liquid, and contains mainly the short bacilli; but from the margins of the track, and speading over the still solid gelatine, are groups of bacilli, arranged in various forms. Besides groups which are in direct continuity with the track, there are others scattered about, apparently unconnected with the main mass. These vary in shape from the incessant movement of the bacilli. In plate cultivations the colonies are, as a rule, at first globular; but very soon the bacilli are seen to shoot into the gelatine, forming loops, and these loops often run out for a long distance into the jelly, and are twisted, giving rise to what Hanser terms "spiraline forms."

Bacteria may be divided into four groups, according to the effects produced in the media in which they grow.

I. The choromogenic or pigment-forming variety. This species may be said to be of historical interest. In the Book of Exodus it is said, that "the Lord spake unto Moses, Say unto Aaron, Take thy rod, and stretch out thine hand upon the waters of Egypt, upon their streams, upon their rivers, and upon their ponds, and upon all their pools of water, that they may become blood; and that there may be blood throughout all the land of Egypt, both in vessels of wood, and in vessels of stone. And Moses and Aaron did so, as the Lord commanded; and he lifted up the rod, and smote the waters that were in the river, in the sight of Pharaoh, and in the sight of his servants; and all the waters that were in the river were turned to blood. And the fish that was in the river died; and the river stank, and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt." This variety occurs in marshy districts, forming a blood-red coloured growth on the surface of pools and lakes, and it is probably in them we find an explanation of the plague above referred to. A similar growth is sometimes found in snow. It is known by the name of *micrococcus prodigiosus*. It has also been found on bread, and in an epidemic form attacked the bakehouses in Paris. It has appeared spontaneously on the sacred bread or host, and has led to pilgrimages to see it.

Another growth produces a blue colour in milk, not the sky-blue which we sometimes hear of. There are other chromogenic bacteria, which produce a violet pigment, and one a delicate green. Another micrococcus recently isolated is called *magenta micrococcus*, and in this species the pigment is retained in the cells.

II. The zymogenic bacteria are those which produce fermentation; such as in the fermentation of malt, one variety tending to the formation of alcohol, and another to the production of glucose. Hence the great difference between English and German beers; the former being much more alcoholic, the latter containing more glucose, and fat-forming materials. And again another form will cause alcohol to take up oxygen, and so convert it into vinegar and water. Another causes the conversion of sugar of milk into lactic acid, and so turns milk sour. These illustrations will show that we are surrounded on every hand by these minute organisms, and explain what an enormous influence they have on us.

III. The saprogenic or putrefactive bacteria produce changes very similar to fermentation, in complex organic substances.

By the action of these bacteria in the putrefactive substances poisonous alkaloids are formed, which are called ptomaines.

IV. Pathogenic, or disease-producing organisms. I have before referred to the method of proof that these organisms really do produce disease, and are not merely the concomitants thereof. This is clearly proved when, as in the bacillus of anthrax the cultivation has been passed through successive generations, and then by reproducing the disease in a suitable animal. The malignancy of anthrax is very well known. The disease has been reproduced in cattle by their grazing on land under which animals which have died from anthrax are buried. The spores can be kept for years; for instance on silk threads soaked in a cultivation of anthrax on potato—the anthrax grows readily on potato—and then if the silk threads are soaked in a mixture of the potato with sterilised water, they become impregnated with the spores. The minutest portion introduced under the skin of an animal will produce anthrax years afterwards.

Forty years ago the anthrax bacillus was discovered in the blood of animals suffering from splenic fever. Thirteen years afterward, Davaine showed that the disease could be produced by inoculation; but it was not until 1877, when Professor Koch introduced the methods of cultivation before referred to, that the bacillus was isolated, and it was proved that it, and it alone, produced the disease. One difficulty in the way of proving the dependence of a disease on a given bacillus—is that bacilli which may be found in healthy secretions such as the saliva—will produce disease in the lower animals; so that unless precisely the same disease is produced, the microbes cannot be said to be the cause.

The exact manner in which these microbes cause disease has not been worked out; possibly, like the putrefactive organisms, they take up certain elements in the media, the blood, and the like, in which they grow, and leave behind certain poisonous alkaloids.

A very interesting enquiry is, How long can these minute organisms exist?

Professor Weismann, of Freiburg, in a work on the duration of life, says that one-celled beings, strictly speaking, do not die—that they are immortal. As they increase by scission or division, and each piece is a new life, so they may be said never to die except by accident. He says, "Natural death happens only to many-celled beings; one-celled beings do not possess it as yet." The encysted stage is comparable to death. Some lower forms of life, as the amœbæ, become motionless, and apparently enclosed, as it were, in a cyst; and then, as Dr. Dallinger describes it, suddenly a cross, as it were, is seen to appear, dividing it into four quarters, and then it bursts into myriads of new spores, which develope into fresh amœbæ. Strictly speaking, then, this creature cannot be said to have died at all, but is really, unless killed by design or accidentally, immortal.

The duration of life among many of the lower forms is much longer than at first sight would appear. For instance, a mollusc has been kept alive, I believe at Edinburgh, for more than eighty years. Sir John Lubbock recently had a queen ant die, which he had kept for fourteen years, and which was of course presumably older. Fish again are known to be long-lived; at any rate, certain species. A pike was taken out of a pond in Suabia, which had a ring attached to it, stating that it was put in there by the Emperor Barbarossa two hundred years before. Again, amongst the higher animals elephants and parrots are very long-lived. The story of Humboldt's parrot is very well known. He found in South America a parrot which spoke, but the native Indians could not understand what the parrot said. It turned out that it was talking the language of a race of Indians which had been long extinct.

According to Weismann natural death appears first amongst the lowest metazoa (*Hetero-plastides*). Somatic or body cells alone die, not the digestive cells. Directing all the cells to one generation, the somatic or real body cells endured only for a limited time. Later on, among the higher metazoa, the somatic cell became endowed with the power of prolonging its life for several generations, and life became correspondingly longer. This formation went hand in hand with the differentiation of the cells of the organisms, according to the principle of division of labour in cells of generation, and was brought about by the process of natural selection. This biogenetic principle applies only to the many-celled beings; it has no application to the one-celled beings. Life is a lasting one, not a periodically interrupted one. Since it in its lowest forms has appeared on the earth, it has continued without interruption, only its forms have changed; and all individuals of all forms which live in the present day, even of the highest, have been derived in an uninterrupted chain from that first and lowest. There exists then a complete continuity of life. Death is not at all that limitation of life which has been assumed to be a necessary attribute of all organisms, but does not apply to monads or one-celled beings, including higher organised infusoria, as well as the amœbæ. The argument for this rests, Weismann says, on the one hand, on the reproduction by scission or division in the monoplastic cells; and, on the other hand, through the necessity of reproduction of the retention of the one-celled condition of development among the polyplastides or many-celled beings.

As death itself, so also the shorter or longer duration of life rests entirely on fitness. Death does not rest in a primordial quality of the living substance, nor is it necessarily united with reproduction, nor even a necessary consequence of it.

In the observations I have just been making I have been quoting mainly from Weismann. The language is, I am afraid, somewhat involved, and perhaps has suffered in translation; but what it appears to come to is this, that monads, by the very fact of their reproduction being by division, do not die a natural death. The one becomes two separate beings. The two again subdivide and so on *ad infinitum*. Possibly this is something of a truism, but I do not think that anyone before Weismann has elaborated the matter.

The practical applications of the knowledge of the life history of the various forms of microbes are numerous. I have referred incidentally to some. Even the potato disease, which no doubt is due to the development of air-borne spores, where a suitable nidus is found, has been checked to a great extent by ascertaining what varieties will best resist the disease. Thus by a process of natural selection, aided by the efforts of man, the disease may be stamped out. Again, the study by Pasteur of the nature of the grape disease, viz., the *phyloxera,* has lead to the proper means being taken to eradicate it. But perhaps the most brilliant example is the method of treatment adopted by Pasteur to prevent the development of hydrophobia in those who have unfortunately been bitten by rabid animals.

Although up to the present time the microbe of hydrophobia has not been isolated, there is, as Pasteur says, as little doubt that it exists as that stars exist in the heavens which we have not yet seen. The treatment, then, is based on the principle before alluded to; viz., that of attenuating the virus, and so preparing it, that when the patient is inoculated with it in successively increased doses the hydrophobia itself does not take place.

Pasteur found, in the course of his experiments, that the saliva of the dog does not always give rise to rabies, but that the more virulent matter was to be found in the brain and spinal cord. When the poison is injected into the blood the spinal marrow is the part first attacked, the virus locating itself and multiplying there before spreading to other parts. Pasteur has found that the virus of rabies, if carried from the dog to the monkey, and subsequently from monkey to monkey, grows weaker at each passage; and if carried back to the dog, rabit, or guinea-pig, still remains attenuated. But, on the other hand, successive passages from rabbit to rabbit, or from guinea-pig to guinea-pig, increase the virulence of the virus.

This exalted virulence comes to a fixed minimum in the rabbit. If now transferred to the dog it remains exalted, and shows itself to be much more intensely virulent than the virus of ordinary street rabies. So great is this acquired virulence that the new virus injected into the blood-system of a dog unfailingly gives rise to mortal madness.

A logical application of the results just indicated gives us the means of easily rendering dogs refractory to rabies; for we can now prepare and keep at our disposal a series of attenuated viruses of different strength—some not mortal, preserving the animal economy against the ill effects of more active ones, and these latter against the effects of mortal ones.

One difficulty Pasteur had to contend with was to find the period of incubation of the poison. Every one knows the story of the Duke of Richmond, who was bitten by a tame fox, and who died of hydrophobia two years afterwards. Instances in which the disease has developed itself in two or more months are common. Here again there is an agreement with what Watson Cheyne has found in his experiments on the disease produced by a special bacillus in the mouse. It is necessary to have a sufficient quantity of the poison, so to speak, to create the disease. One would have imagined that that would not matter, as the bacilli multiply so rapidly, but it is not so; at any rate in certain cases. If a large quantity of the saliva entered, the incubation would be short; if a small quantity, it might become localised and wither away, or it might, on a more favourable soil, slowly and surely work its way, and develop into madness later on.

Pasteur found, however, that by inoculating rabbits direct into the brain, with the spinal marrow of an ordinary mad dog, the disease was generally fatal on the fifteenth day; and, as before stated, by carrying the inoculation on from one rabbit to another the period of incubation was shortened to seven days.

The official French commission appointed to investigate the truth of this, reported that twenty-three vaccinated dogs (*i.e.*, vaccinated with the attenuated virus before referred to) were bitten by ordinary mad dogs, and that not one of them had taken rabies; on the other hand, sixty-six per cent. of dogs bitten without being previously vaccinated took the disease.

In July, 1885, Pasteur first began to try the effect of inoculating persons to prevent hydrophobia developing, after they were bitten. A boy named Joseph Meister, who had been bitten severely, was brought up from Alsace. It was pretty clear he could not escape being attacked by hydrophobia; his mother had heard of Pasteur saving dogs, so she had faith that he could save human beings. By suspending the spinal cord of a rabbit, which had died of rabies, in pure air for fifteen days, the poison was lessened. The boy was first inoculated with this virus, and then on each successive day for ten days with virus of greater intensity, until at last he was inoculated with virus of one day old. By experiments on rabbits it was found that the virus used up to the six days old from the fifteen days old, was not virulent, but that from the six days old up to one day was increasingly so.

Pasteur considers that once the state of immunity has been reached, there is no danger attaching to the inoculation in any quantity of the most powerful virus. The only consequence is simply to consolidate the refractory state. Joseph Meister did not get hydrophobia, and is still alive.

After this Pasteur treated a great number of cases, inclusive of some Russian peasants bitten by wolves. Of thirty-eight wolf-bitten Russians only three died. The incubation period after wolf bites is shorter than after dogs, and the rate of mortality higher.

In about fifteen months from the first case 2490 had been treated by Pasteur, 1726 being French, of whom ten died, about 1 in 170, the mortality formerly being 1 in 6. It has been argued that a great number of persons who were in no danger from hydrophobia were inoculated, and that in some cases death resulted from the inoculation; it being stated that the numbers were out of all proportion to cases of genuine hydrophobia which had occurred at any former time. It is possible that this may have been the case at first; *i.e.* that some may have been inoculated who had not been bitten by mad dogs. But I think with regard to the latter accusation the care taken to ascertain what doses were sufficient to prevent without causing the disease would prevent such an occurrence; doubtless in some fatal cases the treatment was begun too late.

In 1887 386 persons were bitten in Paris and the neighbourhood by dogs which were rabid. These were all treated, and only two died. There were forty-four others bitten who were not treated, and seven died, being nearly 1 in 6, against 1 in 150. Dr. Dujardin Beaunetz also states that the two who died after treatment did not follow up the treatment regularly. I think this is fairly conclusive as to the benefit of the treatment.

Laboratories have been established now in various parts of the world—in Russia, in America, and elsewhere—in order that this treatment may be carried out, and for investigation into the life-history of the microbes of diseases generally. So far as I am aware there are no means by which the Pasteurian system of treating hydrophobia by prophylaxis can be carried out in England. Doubtless this is, to a great extent, due to the difficulties put in the way of experimenting and using animals by the Antivivisection Act. I do not wish to make any comment on this, but I think our Antivivisection friends should consider whether their efforts do really tend to the better treatment of animals, leaving man out of the question. Do not the facts I have mentioned show that through these experiments of Pasteur he has been able to devise means to prevent animals suffering from anthrax—a very fatal disease—and that dogs who may be unfortunately bitten by a mad (relative) dog need not necessarily be destroyed, but can be treated so as to prevent the disease from developing?

The manner in which the attenuated virus acts in the way it does is not clearly understood. Vaccine lymph prevents small-pox by substituting a milder form of the disease, and so using up, it is supposed, the material in the blood which is favourable to the development of smallpox.

Again, it may be that the blood-cells resist the attack of the fatal microbe by being gradually accustomed to its presence in a milder form, as persons may be accustomed to the use of opium or alcohol, until they can take what would almost immediately kill other persons.

By degrees various living beings can be brought to tolerate quite different environments. Salt-water medusæ can be made to live in fresh. Dr. Dallinger has shown that by gradations some bacteria can be brought to live in a temperature which, if they were exposed to it at the first, would be fatal to them.

An important consideration from a health point of view is, to what extent these microbes will resist heat, and how long they will exist in water. Dr. Grancher finds that the moist-vapour stoves of MM. Geneste and Hersche are powerful enough to destroy microbes, although imbedded in mattrasses, &c., a temperature of 106° C. being easily obtained, the dry-air stove not being so efficacious. Dr. Percy Frankland found that Dr. Koch's comma spirillum of cholera was, in the purest form of distilled water, no longer demonstrable after the ninth day; whilst in London sewage it was found in largely multiplied numbers after twenty-nine days. Organisms which do not naturally have water as a habitat when introduced into it are destroyed in large numbers, but some survive, and then a greater or less multiplication in their numbers subsequently takes place.

With regard to the bacilli of anthrax, they are rapidly destroyed when introduced into London water; but the spores, on the other hand, which, as before stated, have great vitality, will remain alive even in distilled water for ninety days. In polluted well water, Meade Bolton has found that the bacilli of anthrax persist for upwards of ninety days, and the spores for nearly a year; whilst Wolffhugel has found that in polluted river water (the river Pauke, in Berlin), even when diluted tenfold with distilled water, the anthrax bacilli undergoes extensive multiplication.

I trust I have not wearied you with the account I have given of these minute forms of life. I hope I have made it evident what an important bearing they have on the health of the community. I should also like to lay stress on the fact that from various causes the researches into the different forms of disease caused by them, and the method in which they may be combated, cannot be so well carried on in England as abroad. One great cause, to which I have already alluded is, the legal difficulties thrown in the way of research, and again the want of funds. Pasteur is aided in his researches by the State, and this is the case in almost all instances on the Continent, scientific researches, as is well known, being but an indifferent method of finding even the necessaries of life.

I will conclude then by quoting the resolve of Descartes: "Never to accept anything for true which I did not clearly know to be such; and comprise nothing more in my judgment than was presented to my mind so clearly and distinctly as to exclude all ground of doubt."

CONVERSAZIONE.

(4th October, 1888.)

An account of the proceedings at this Conversazione will be found among the Reports.

THE DARTMOOR VOLCANO.

BY R. N. WORTH, F.G.S.

(Read October 18th, 1888.)

Dartmoor is a broken tableland of Granite, of irregular outline. The greatest length, North to South, is 22½ miles; the greatest breadth, East to West, 18⅓ miles. The average breadth cannot, however, be taken as more than 15 miles; nor the average length as more than 20. The area is therefore about 300 square miles. These are the measurements of the visible granite; but the granite is surrounded by a belt of altered rocks—slates and grits—beneath which it dips, which have been changed in character by its proximity, and which indicate its wider presence at no great depth. Including this zone, the area affected by the physical phenomena of Dartmoor is not far short of 400 square miles.

Other elevated granitic regions of similar character, which cannot be dissociated from Dartmoor in origin, occur at intervals to the westward. Chief are the Hingston, Brown Willy, Hensborough, Carnmenellis, Land's End, and Scilly bosses; but more or less closely grouped with these are smaller patches, which, in several localities where mining operations are carried on, have proved to be connected with the main masses at no great depth, the surface interval being occupied by shallow basins of the slaty rocks commonly grouped as killas. There is every reason to assign all these granitic areas to one and the same geological age, and to one and the same series of causes; and there is good ground also to suggest that the connection proved to exist between the minor masses exists, at a greater depth, between the larger; and that from Dartmoor to Scilly, therefore, we are dealing with one and the same granitic axis, most strongly marked in Dartmoor, and gradually decreasing in elevation and importance westward, where initial causes seem to have been least active and subsequent changes most prominent. Denudation seems to have increased in activity from the north-eastern flank of Dartmoor, where

Carboniferous rocks occupy the surface, exposing in turn the lower strata of Devonian, Silurian, and probably Cambrian rocks in the West Cornwall mining district, with Archæan in the Lizard promontory. Dartmoor is about as large as all the other granitic areas of the West together, and has always had great relative importance.

On a wide view Dartmoor presents the aspect of a tableland, with an elevation more decided in relation to the surrounding country than the rise of its highest points above its average level. This plateau character is best recognised in such a distant view as that from the Cheesewring. It can be seen from Staddon Heights, Maker, in a minor degree from Roborough Down, and several other points; but the Cheesewring *coup d'œil* is most distinctive. It is far more strongly marked on the south of the Moor than on the north, where isolated heights are more common in the outskirts.

The average height of Dartmoor above sea-level is 1200 feet, whereas the two highest points—High Willhayse and Yes Tor—are 2039 feet and 2029 feet respectively. The general contours are peculiar. The outer hills, the boundary rampart of the granite region, rise as a rule between 800 and 1000 feet, while the more broken belt of heights immediately succeeding averages between 1200 and 1400. Still further in are two main areas of special elevation—the one in the northern and the other in the southern quarter—and these are divided by a line which follows practically the main road across the Moor from Dousland Barn to Moretonhampstead, and undulates between 1000 and 1400 feet.

The most elevated tract of Dartmoor is six miles in length N.N.W. to S.S.E., from Yes Tor to Cut Hill, and three miles wide. None of the heights here are under 1800 feet, and they range up to 2039. Near the centre of this region, approaching 1900 feet above sea-level, is Cranmere, from the bogs around which, at a general elevation exceeding 1800 feet, issue the head waters of the Dart, Tavy, Okement, Taw, and Teign.

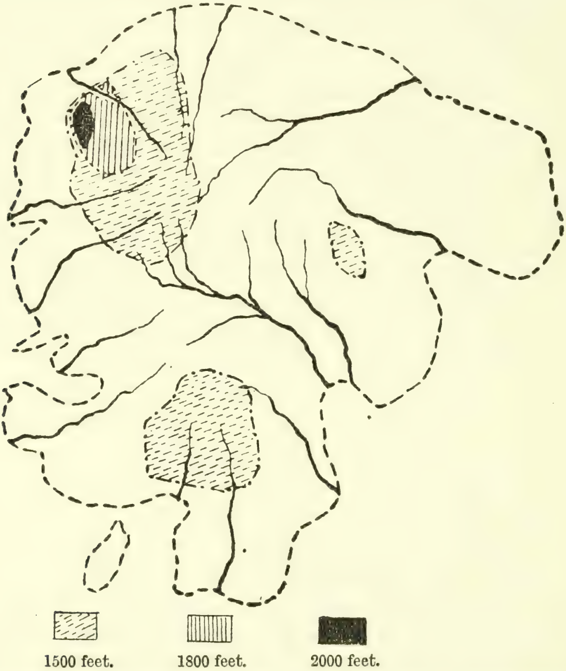
East, and west, and south of this area, for a space of five miles broad and seven miles long, the tors attain a height of 1700 feet; and beyond it, on the N.E., Cosdon Beacon rises in solitary majesty to 1784. The descent from the Moor at its extreme N.W. corner, near Okehampton, is more sudden and marked than at any other point, but otherwise it is somewhat less decided on the west than on the east.

A tongue of the northern high ground trends southward by Great Mis Tor, Bair Down, and North Hessary Tor, each over 1700 feet.

The high land of the southern quarter rises at Peters Bound Stone to 1694 feet, and for an area of about six miles by four has an elevation of 1500.

The only other specially-elevated region is in the east, where Rippon Tor and Hamildon are the most prominent heights.

These points will be more clearly recognised in the diagram, where it will be seen that Dartmoor has two main areas of elevation and two main systems of watershed, the principal rivers flowing east, west, north, and south from around Cranmere; while the Avon, Erme, Yealm, Plym, and Meavy issue west, south, and east from the southern centre, the northern streams of which flow into the Dart.



Sketch Map of Dartmoor, showing Contour Areas, and Main Watersheds.

This map represents the Dartmoor granite, with a general height of 1200 feet. The contours shown are those in which the leading points reach the elevations given. They are general contour *areas*, not *lines*.

The Dartmoor heights are mainly connected ranges of high land, with a general run north and south. There are only two points where a contrary tendency is strongly marked. South of Fur Tor and Cut Hill a ridge runs irregularly east and west from the valley of the East Dart to that of the Tavy. In the southern quarter a semicircle of high ground sweeps round Fox Tor Mire eastward and southward, and extends westward toward Cramber Tor. The heights are more continuous in the central portion of the Moor, east and west of which there are many isolated hills.

The fall in the upper waters of the Dartmoor rivers is very considerable, and if their volume in these regions were any way proportionate (only the case in very rainy weather), their excavating work would be enormous. The two branches of the Dart, to Post Bridge and Two Bridges respectively, fall about 150 feet a mile; thence to Dartmeet and to the edge of the Moor at Holne, 80 feet. Holne Bridge is just 200 feet above datum. The Teign gives much the same results. The Taw and the Okements fall still more rapidly—from 180 to 200 feet a mile. The Tavy, between its source and Tavistock, averages about 140 feet a mile; from Tavy Cleave onward about 90. The Walkham falls at the rate of 160 feet a mile to Merivale Bridge, thence to the confines of the Moor about 80. The Plym to Shaugh Bridge falls some 160 feet a mile. The Meavy about 120–150 between the source and the Head Weir, 90 thence to Shaugh Bridge.

The sudden drop from the inferior outskirts of the Moor to the bordering lowlands is strikingly shown in the ravines through which the chief streams descend. The Plym, at the Dewerstone; the Meavy, at Yannadon; the Walkham, at Huckworthy; the Tavy, at Tavy Cleave; the Lyd, at the Gorge; the West Okement, at Meldon; the Taw, at Belstone Cleave; the Teign, at Fingle Bridge; the Bovey, at Lustleigh Cleave; the Dart, at Holne; the Erme, at Ivybridge; the Yealm, at Awns and Dendles. All these tell one tale, as to which we shall have more to say anon.

Such are the chief physical characters of modern Dartmoor.

The key to the origin and geological history of Dartmoor is the nature of the rock of which it is mainly formed, to which its other physical conditions are subordinate. The idea that granite is the primary rock of the world—once firmly held—is long quite out of date, since it has been recognised that there are granites of differing geological ages; and instead of one hypothesis for the origin of granite, there are now four—(1) The original primary idea, repeated only by the uninformed; (2) The generally received view that granite is of igneous origin; (3) The suggestion that it is really an altered stratified rock; (4) The compromise theory that as there are granites of different ages, so there may be granites of different origins—some igneous and some metamorphic.

With the first and fourth of these we have nought to do. The one is dead; and as for the other, we are only concerned with the granite of Dartmoor and its continuation west, and what may be proved touching them.

The difference between the second and third hypotheses is not absolute. We are not really troubled about the prior condition of the material which now forms the Dartmoor granite. It may have been igneous from the beginning (and all rocks were originally igneous), or it may have been a sedimentary rock, subjected to destructive action and reconstitution. At the same time it should be mentioned that in 1875 the late Mr. J. A. Phillips clearly proved that granite and elvan could not have been formed out of killas, which is deficient in silica, and contains more soda than potash, while granite and elvan are potassic.[1] If therefore our granites and elvans are metamorphic, special forms of sedimentary rock must have been provided, occupying exactly the same areas, which have left no trace behind!

Our business, however, is not with original character, but with agency. And here again the dispute is in part one of terms. Most, if not all, geologists are agreed that what is now granite has been in a fluid or semi-fluid, or at least pasty condition, produced in some way by heat. The controversy, so far as we have to do with it, is narrowed to one point—whether the heat was dry or wet, thermal simply, or hydrothermal—whether, in plain English, our granite was smelted or stewed.

And the advocates of the rival views also agree that, however the fluid state was originally produced, the consolidation of the granite must have taken place under considerable pressure.

Liquid and gaseous inclusions frequently occur in cavities in the constituents of granite, notably in the quartz, and arguing from these Mr. Sorby long since announced that the Cornish granites had as a mean consolidated at a temperature of 216 C., and under a pressure equivalent to that of 55,000 feet of rock.[2] The late Mr. Clifton Ward in the same way estimated the granites of Westmoreland and Cumberland to show a mean pressure of 44,000 feet—the Skiddaw granite indicating 52,000, with a suggested temperature of 360 C. Mr. Sorby's mean for the Highland granites gives a pressure-equivalent of 76,000 feet.

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[1] *Quar. Jour. Geol. Soc.* xxxi. 338.

Mr. Sorby's conclusions as to the origin of granite are that it might have been formed under conditions "combining at once igneous fusion, aqueous solution, and gaseous sublimation," and that the pressure under which granite solidified was analogous to that of lavas "solidified at the focus of their activity, as though these rocks were the non-erupted lavas of ancient volcanos variously protruded among the superincumbent strata."

Professor Prestwich, adopting the hydro-thermal or extreme metamorphic view, criticises Mr. Sorby's details, while agreeing in the main with his inferences, and thinks that "granite must have consolidated under extreme pressure, and at a temperature probably not exceeding about 700 Fahrenheit, or under that of low red-heat."

It may thus be accepted as a definite article of geological faith that granite was at one time in a highly heated and plastic state—to go no further.

But it has been argued that granite rocks have been changed *in situ*—that the granite is simply the product of a gigantic stewing operation, on strata which practically occupy the same position now as before, though changed in character.

The answer in our case is perfectly clear, whether on physical or on chemical grounds. If our granites are only altered forms of the rocks among which they lie, then one must pass into the other by gradual change. This is never the case. Wherever you trace the Devon or Cornish granites in contact with other rocks you find the line of junction perfectly sharp and distinct. Sir Warington Smyth has asserted "positively that careful research will reveal numerous places on these granite hills, to be seen sometimes with great distinctness underground . . . where the ends of schistose strata may be seen to abut against the face of granite."

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[2] *Quar. Jour. Geol. Soc.* xiv.

Moreover, granite veins may be seen at many places thrust into the adjacent rocks, in a manner utterly irreconcilable with any metamorphic hypothesis. Again, the rocks bordering the granite all more or less exhibit traces of alteration, gradually dying away from the granitic margin, just as the granite should if it had been the result of a metamorphic process, and were not of independent origin. I put the inevitable conclusion in the words of Sir Warington Smith, "From these various indications . . . it is clear that the slaty rocks . . . have been rudely disturbed and broken through by the granite, and that they are probably based upon a vast mass of that material lying at unknown depths between the hills where it rises into view."

This identification of the Dartmoor granite as a true igneous rock is the first stage in our inquiry. Igneous rocks are commonly classed in two great divisions—*volcanic*, "such as have been ejected, or have welled out on the surface," and *plutonic*, "such as have been formed under conditions of depth and pressure."[3] Petrological research has, however, made it absolutely certain that (and I use the words of Professor Prestwich rather than my own) this "in many cases indicates a difference of conditions rather than of origin. The volcanic rocks having erupted on the surface, and having cooled quickly and without pressure, have solidified as non-crystalline and amorphous rocks, whereas the so-called plutonic rocks, not having been erupted at the surface, and cooling slowly and under great pressure, have solidified as crystalline rocks."[4]

There is another classification of igneous rocks, according to their composition, into *acidic* and *basic.* These form two great series, in both of which plutonic and volcanic varieties are found. The acidic rocks have an average percentage of silica of 70; the basic of 50; and while alkalies are largely represented in the one, alkaline earths are conspicuous in the other.

As long ago as 1874 Professor Judd, writing on the "Tertiary Volcanoes of the Highlands,"[5] proved that in the acidic series the plutonic form, granite, passed upwards through syenitic granite into felsite (quartz-porphyry), then into trachytic-lava (felstone, or rhyolite), and finally into a volcanic glass (pitchstone).

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[3] Prestwich's *Geology*, i. 35.

[4] *Geology*, i. 381.

[5] *Quar. Jour. Geol. Soc.* xxx. 220, *et seq.*

The basic in like manner passed from the plutonic gabbro, through augitic-gabbro and dolerite, into basalt-lava, and finally into the basalt-glass known as tachylyte.

These are but main varieties, and the unvarying result of petrographic research since then has been to prove full intermediate gradations from the plutonic to the volcanic types, so that one and the same original fluid mass of molten matter may put on all these varieties of lithological form. Granite, if it reaches the surface, becomes lava.

In the paper from which I have quoted, Professor Judd traced the history of the great Tertiary volcanoes of Mull, Ardnamurchan, Rum, Skye, St. Kilda, and of the Grampian chain—in each and all of which volcanic rocks have been associated with great central granitic masses; and in his concluding passages observed:

"From the active volcanoes of Etna, Vesuvius, and Skaptar Jokul, the step to the ruined piles of the Mont Dorè and the Cantal is an easy one, and with these last we have little difficulty in perceiving the parallelism of the phenomena displayed by the rocks in the central mountain group of Mull. From the condition of the volcanic rocks in Mull to that in Skye the transition is obvious, and from the latter to Beinn Nevis, and thence to the granitic bosses of Cairngorm, the Moor of Rannoch and the Ross of Mull, can easily be made; nor will any difficulty be experienced in passing from these latter to the wide-spreading tracts of granite, such as that of Leinster. . . .

"Whilst, on the one hand, we are led to conclude that great tracts of granite like that of Leinster may once have been surmounted by vast volcanic piles, we cannot, on the other hand, doubt that the subaerial volcanic phenomena of Iceland, Sicily, and the Andes are accompanied by innumerable igneous injections in subjacent strata, and the formation of masses of granite, syenite, diorite, and gabbro at great distances beneath them."

For Leinster read Dartmoor, and the parallel is complete.

We find then that the granite of Dartmoor is an igneous intrusive rock, formed at a great depth beneath the surface, and therefore exposed by the removal of the rocks beneath which it consolidated. We learn also that granite is but a phase; and that the same matter now found as granite would, had it issued to the light, have formed a trachytic-lava.[6] Just as we find water in the solid form as ice, the fluid as water, the vaporous as steam, the gaseous as oxygen and hydrogen—the change is less in the thing than in its conditions.

The next question is whether we have any evidence that the intrusive mass, of which the granite of Dartmoor formed a basal part, ever reached the surface as a volcano. We have seen that this granite must have consolidated at a great depth beneath vast masses of rock now removed. Can we gather what these rocks were?

We have had the figures of Mr. Sorby and Mr. Ward touching the pressure under which various granites have consolidated, the mean for the Cornish and Devon granites being the equivalent of 55,000 feet of rock. But it is not to be understood that our present Dartmoor granite was ever buried beneath ten miles of strata. Mr. Sorby remarks that "in some cases the pressure was probably much greater than that of the superincumbent rocks, for otherwise they could never have been fractured and elevated; whereas in other cases it may have been much less, if the internal pressure had been in any way relieved."[7] In other words, if the weight of the overlying rocks were equal to the pressure of consolidation there would be practically no surface change. If it were less, the extra force indicated would be expended by the eruptive granite in upheaval and distortion, to which relief might or might not be given by a volcanic vent.

Now as there is abundant evidence of a great elevating force in and around Dartmoor, in the tilting of the slates, &c., it is clear that the superincumbent mass cannot have been anything like the ten miles whose equivalent pressure has been calculated.

The Dartmoor granite rises through Devonian strata on the south, and partially on the west and south-east; through Carboniferous strata on the north, partially on the west, and to a larger extent on the east. And as it sends veins not only into the Devonian, but into the Carboniferous rocks, it is plainly younger than they are, since it could not transverse that which did not previously exist.[8] On the other hand, as pebbles and fragments of Dartmoor rocks are found in the local breccias and conglomerates which represent the margins of the ancient Triassic sea, it is clear not only that Dartmoor must have been erupted, but that some of its underlying rocks must have been liable to denuding influences—*i.e.*, that some of its granites must have been exposed at the surface—before these derived beds were formed.

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[6] Mr. J. A. Phillips, in 1875, illustrated the practical identity between granite, elvan, and rhyolite.—*Quar. Jour. Geol. Soc.* xxxi. 338.

[7] *Quar. Jour. Geol. Soc.* xiv. 491.

Thus we are led to conclude that before the elevation of the Dartmoor region began the area was occupied by Carboniferous and Devonian rocks, the former resting upon Devonian, and the latter possibly in part upon Silurian, as traces of that system seem to exist in Devon as well as in Cornwall. Both the Devonian and the Carboniferous rocks of the Dartmoor area had been disturbed by igneous action before the upheaval of the granite. Not only have we lava- and ash-beds contemporaneous with the Devonian rocks, especially in the south-west of the county, but around the Moor there are bands and bosses of intrusive plutonic rocks partially following the outline of the granite in great curves, as at the north-western corner, and specially prominent near Mary Tavy and Tavistock, where they form the eminences of White Tor and Cocks Tor—the highest non-granitic points of the county. These gabbros, as they have frequently been called, though chiefly falling among the modern epidiorites, are the vestiges of a widespread pre-Dartmoor igneous activity in the intrusion of basic igneous rocks, and their exceptional development in the Mary Tavy district has been thought to indicate that we have there exposed some of the lowest stratified rocks brought up by the granite in this county. It may be that they represent the earlier stages of the eruptive epoch which eventually gave us Dartmoor, for their relations to the granite, here and also in Cornwall, are too persistent to be accidental. It is not unusual for one eruptive centre at one time to produce basic and at another acidic rocks.

Thus we have to account for the presence of the granite, the disappearance of the rocks which once covered it, and the relations between the granite and its stratified surroundings.

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[8] Certain of the veins on the north of Dartmoor contain fragments of Carboniferous rocks, some not quite detached, some with perfect angles. (G. W. ORMEROD, *Trans. Devon. Assoc.* ii. 128.)

We at once dismiss, with Sir Warington Smyth, "the old Wernerian idea, that" the associated "schists were deposited after the solidification of the granite, wrapping smoothly round it." Indeed, that notion had to be abandoned with the exploded hypothesis of the primary granitic character.

As an igneous rock, the Dartmoor granite might have been intruded in four ways.

A. It might have risen directly through the Devonian and Carboniferous strata, bearing up on its surface the displaced rocks of its area. But in that case, its boundaries must have been broken or "fault" boundaries, and the fractured ends of the surrounding rocks must have terminated abruptly against it, instead of being tilted with it and lying partially upon it.

B. It might have elevated the superincumbent mass in a huge unbroken dome. But in that case, the removal of the upper portion of this dome would have shown the lowest rocks, in all cases, next the granite; whereas it is seen to pass under Devonian slates on the south, and under Carboniferous slates and grits on the north.

C. To avoid these difficulties, Mr. Ussher, F.G.S., recently suggested a laccolitic origin. His hypothesis was, that the granite came up from below through a central channel, and then forced itself in all directions between the beds and along lines of weakness under the surface, the final form being comparable to that of a gigantic mushroom. This would fully account for the relations of the granite to the investing rocks, but is, I think, inadmissable for other reasons. *First.* We cannot treat the Dartmoor granite as an isolated fact; hence, instead of one laccolite, we should have to accept several. *Second.* On the laccolite view there must be stratified rocks, except at the neck, below the granite as well as above, and in sinking through the granite we should come upon them. This is contrary to all experience. In the Cornish mines the lodes are continually followed down from the killas into the granite, and the two rocks invariably meet at an angle, as if the slate were lying in a huge granitic lap. But when the granite is once reached, there is no return to the killas, with the single exception that in the Breage district the rule is proved by the granite being cut in veins protruded into the killas. *Third.* It is impossible to me to conceive of such an immense body of molten matter as a laccolite the size of Dartmoor, three to four hundred square miles in area, and from existing data at least half a mile thick, forming a subterranean lake, without finding its way to the surface somewhere, and putting on volcanic characters.

D. There remains therefore only the volcanic hypothesis.

The point on which I wish to lay special stress is this—that there must have been a period in the eruption of the Dartmoor granite when the superincumbent mass ceased only to be lifted, and began to be thrust. Coming up from below—as the granite must have done from its present contour—partially in a wedge-shaped or conical form, the first erupted material leading the way in the line of greatest weakness, the Devonian and Carboniferous rocks must eventually have been driven apart as well as heaved. This thrust would become stronger as the erupted body increased in mass, and it would continue to grow in force until the tension near the surface was relieved. The lower rocks would be the first to feel the separating action. Hence upheaval would be quite consistent with Devonian and Carboniferous strata still retaining their relative positions on the flanks.

There is absolute proof that something of this sort took place, in the fact that the Carboniferous and Devonian rocks about Dartmoor, the latter especially, now occupy, by tilting and repetition, a much narrower lateral area than originally. They were once horizontal, or approximately so; they are now mainly inclined at high angles and plicated.

Some of these rocks, however, were simply lifted; where they were caught in a hollow of the irregularly uprising granite. There are talcose slates, for example, approximately horizontal near Slade, in the lap between the main granitic mass and the Crownhill island, saved from tilting by the protecting elevations on either side.

It will suffice if I confine my illustration of the effects of thrust to the Devonian rocks between Dartmoor and Plymouth Sound. They have not only been tilted, but thrown into a series of folds, partially identified by the repetition of certain beds; so that the nine miles or so of Devonian rocks between Shaugh and Wembury must contain, at the very lowest estimate, strata that originally extended over twelve or fourteen. These thrust effects are thus well marked in this locality, because there was a great buttress of Archæan rock in the Channel, now represented by the Eddystone Reef, against which the Devonians were driven, and which, by its resistance, increased the plication. Where the rocks were freer to move the folds are less pronounced; but similar effects are visible at many points round the Moor, where they have not been obscured by complicated earth movements or subsequent disturbance.

If the stratified rocks between Dartmoor and the Channel are largely in excess of those that originally filled that space, whence have they come if not from part of the Dartmoor area? And if the Dartmoor area, here and elsewhere, was cleared by the eruption of the granite of so much of its pre-granitic strata, is it not inevitable that the molten mass must have issued to the light as a volcano?

It is possible that to some of my hearers this may seem too large a draft on the powers of Nature; but in the most recent conclusions of the Geological Survey on Highland Geology I find the following passage:

> "By means of powerful thrusts the Silurian strata were piled on each other, and huge slices of the old Archæan platform, with the Cambrian and Silurian strata resting on it, were driven westwards for miles."

We are dealing with gigantic phenomena, and we must allow adequate causes.

It is a natural suggestion, that if the Dartmoor granite ever passed upwards into volcanic equivalents of the acidic series, some of these rocks ought to be found. Considering the enormous amount of denudation to which the area has been exposed, and the comparatively small proportion these rocks would bear to the main intrusive mass, their absence, however, could be accounted for. Professor Judd has shown that in Ben Nevis, a volcano of the newer Palæozoic period, much of the same date as Dartmoor, we have resting on the basal mass of coarse-grained porphyritic granite, and graduating thence, a fine-grained granite, graduating into felsite, which in turn sends veins into the fine-grained granite, and is surmounted by felstone lavas and volcanic agglomerates alternating; the whole existing upper series being comprised in an upward range of 2000 feet only.

The preservation of these volcanic rocks is quite exceptional at

Ben Nevis and at Glencoe, and the district generally is as free from them as Dartmoor. But if we have no beds of felstone, we have what amounts to much the same thing—veins of felsitic rock—in the elvans; and I can speak from personal observation of the similarity between some of our felsites, or quartz-porphyries, and those of Glencoe.

The fact that our elvans[9] are of later date than the consolidation of the granite which, in common with the associated rocks, they traverse, has long been recognized; but sufficient emphasis has not hitherto been laid upon the different physical conditions which the formation of these two classes of rocks, from what is practically the same magma, or mother-liquor, indicate. The elvans point incontestably to the long continuance of violent eruptive action under another stage of environments than those attending the formation of the granite. Some of them run for miles as dykes of unknown depth, and it is idle to assume that the forces producing their intrusion expended themselves underground, and that all upward movement stopped short of the surface in the more prominent examples. They are essentially illustrations of volcanic as distinct from plutonic activity, and while not in themselves true lava, are the next thing to it, and readily graduate into it.[1]

These elvans demand closer study than they have had, and some of them illustrate the wide range of rock varieties produced from one original magma in a very remarkable manner. The Grenofen elvan, which at the Grenofen quarry is rather a syenitic-granite with a little interstitial felsitic matter than an elvan, is cut in the tunnel near Shillamill on the new line from Tavistock, and might there be regarded as an ordinary loose-textured granite—a fact easily accounted for by the greater depth of consolidation. Still further west, on Morwell Down, at a greater elevation, it has a more distinctive felsitic type, and presents a semi-vitreous compact ground-mass, in which quartz, felspar, and mica are porphyritically developed. The Roborough

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[9] The indefiniteness of this local term, while disqualifying it for strict scientific reference, gives it a special value here, where strict definition is not required, and is indeed at this stage undesirable.

[1] Since this lecture was delivered, a paper by the writer on the "Elvans and Volcanic Rocks of Dartmoor" has been read before the Geological Society.

Down elvan on the Down itself has generally a granular-felsitic base, with pyramidal crystals of quartz, and hollows from which similar crystals have disappeared. But in the valley at Milton and on to Lophill it displays a much wider range. One variety has a compact granular-felsitic base, thickly studded with well-formed porphyritic crystals of quartz and felspar—much nearer the granitic type. Another has a semi-vitreous quartzose base, with porphyritic felspars and a quantity of black mica. Yet another is so even grained and granular that the untrained observer would take it for a sandstone. But the most remarkable illustration of the protean characters an elvan may assume within a short distance is supplied by the dyke cut through on the new Tavistock line near Shillamill. The variation here in breadth is so well marked that examples taken within a few feet of each other might be supposed to come from as many different dykes. The centre is porphyritic, much like the Grenofen, and this graduates into more even-grained and felspathic varieties on each side, while the outer portions are largely quartzose. We have the passage from all but typical granite into syenitic quartz-porphyry within a few yards, and there is every reason to believe that this, with similar elvans, passes into true granite in depth.[2]

Here and there in *dêbris* of Dartmoor origin, both on and off the Moor, are found fragments of felstone of a more or less rhyolitic character, remnants of genuine felsitic lava streams. We do not find them *in situ* like the granites and elvans, but there they lie—relics of rocks that could not have consolidated in depth and under pressure, and which must have had a surface origin.

The best example of these in my possession is from the neighbourhood of Lee Moor—a grey compact felstone, partially banded, with well-marked fluidal structure, and enclosing fragments of quartz and felspar, and of igneous rock, apparently of andesitic type, closely resembling some in the volcanic grit from Cattedown, to be described hereafter.

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[2] The frequent passage of granite into veins of pegmatite is worth noting in this connection. Many of the elvans are really micro-pegmatites, and differ from these veins only in the smaller size of the quartz and felspar crystals, between which and indeterminable felsitic matter there is every stage of gradation.

We find similar indications in the ancient detritus preserved in the Triassic conglomerate. While granites are few, elvans abound, and rhyolites (using that term in a wide general sense) are fairly prominent—precisely what we should expect to result from an early stage of denudation, when the rocks dealt with were generally of the middle and surface types, and the area of granite exposed was comparatively small. The Teignmouth conglomerate has yielded trachytic rock with large vesicles elongated in the direction of flow, more ordinary rhyolites, perlitic felsite, vesicular felsite, mica-andesite, and a wide range of elvans—granular, compact, and porphyritic—some identical in character with varieties occurring on the Moor *in situ* now.

It is further noteworthy that the great bulk of the granitoid pebbles found on the beaches of the south coast of Devon are felsites, or elvans. Making every allowance for the frequently superior lasting powers of compact over granular rocks, we see here also that the felstones must once have been far more abundant in the moorland area than now. I have noted this at Slapton, near the mouth of the Erme, and elsewhere; and a number of granitoid pebbles, collected by my son at Grey Lake Cove, outside the mouth of the Yealm, proved to be all more or less felsitic. The modern river beds of the Moor present very different characteristics; yet the ancient detrital deposits in the bottoms are often as markedly elvanitic, telling the same tale as the beaches. But the most interesting facts under this head have yet to be noted. The fortunate discovery by Mr. R. Burnard of a very ancient detritus at Cattedown, clearly in its main features of Dartmoor origin (but so old that it carries us back to a time when Cretaceous and Liassic rocks still existed on the southern flanks of the moorland region, within the watershed of the Tavy and the Plym), has yielded examples of volcanic rocks hitherto unknown in this county. There are two varieties of andesite, which Professor Bonney says closely resemble those of the Andes; and a volcanic grit, which he regards as one of the most remarkable rocks he has ever seen, and which he has very kindly described as follows:

"The rock is composed of more or less rounded fragments, cemented by a little 'paste,' which is probably quartz, sometimes clear and chalcedonic, sometimes crowded with dust-like particles. Some of the fragments are felspar, fairly irregular in outline, in part at least plagioclase. One or two may be quartz; one or two are a kind of viridite, probably replacing a pyroxenic mineral; and one small grain resembles epidote. The rock fragments are all, so far as I can see, of igneous origin. Some are fairly clear, some a rich brown colour, some almost black with opacite; some are homogeneous, except for a little opacite and some belonites or trichites of a dark grey colour, which often are grouped in more or less dendritic forms or bundles like rootlets. A few of these grains are still isotropic, but most of those which are transparent exhibit devitrification structure. Small spherulites, showing the black cross with the two nicols, are rather common; one fragment seems part of a large spherulite. Other fragments show flow structure; one is perlitic. Clearly several varieties of rock are present, but I think the majority may be referred to andesites, some of which may not be far removed from basalt; others may have a tolerably high percentage of silica. I think the materials have undergone attrition, and have been deposited by water, but believe they have been obtained by the denudation of volcanic cones."

It is very remarkable that this testimony to the existence of local acidic rocks of the volcanic series should have come to light while this lecture was in hand; but in all probability there is more behind. Still, the peak of Dartmoor disappeared so very long ago that the absence of all traces would have been less surprising than their preservation, even in this meagre though unmistakable form.

An attempt to reconstruct the Dartmoor volcano must needs be largely hypothetical; but we can reach sufficiently accurate results by applying conclusions derived from a study of other volcanic piles—ancient and modern. What we commonly find is a central cone, with the sides rising at angles of about thirty degrees, in the midst of a lower elevation formed by slopes of small gradients, six to ten degrees, extending a considerable distance. Hence there are two ways of estimating the size of a volcanic mountain. The igneous base from which the cone of Etna rises is forty miles in diameter; but the mountain proper, as distinct from the lava-covered plains, is some ten miles only. Though truncated, the height of Etna is 10,834 feet. Professor Judd[3] assigned the Tertiary volcano of Mull a basal diameter of thirteen or fourteen miles; and on the analogy of Etna, gave it a height of 14,500 feet.

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[3] *Quar. Jour. Geol. Soc.* xxx. 259.

If we are to treat Dartmoor as a single mountain, we cannot reckon an average basal diameter of less than sixteen miles; with a circumference of fifty, against the forty of Mull and the thirty of Etna; and from this we might fairly infer a total height of 18,000 feet, or three and a half miles.

If we are to regard the two elevated sections of the Moor as representing the degradation of a twinned peak we should not reach so high; but the conclusion that these higher regions of the present day indicate the original contour involves the assumption that denudation had proceeded on tolerably average rates over the whole tract; whereas we know that denudation has been more active on the south, since not only is the elevation less, but Devonian rocks are exposed, in which the work of alteration is greater, indicating greater heat and depth, while the more irregular boundaries suggest a nearer approximation to the base of the eruption. Existing denuding agencies are most powerful where the Moor is highest. Still, the transverse trends by Fur Tor and Fox Tor *may* give some indication of the basal outlines of a crater.

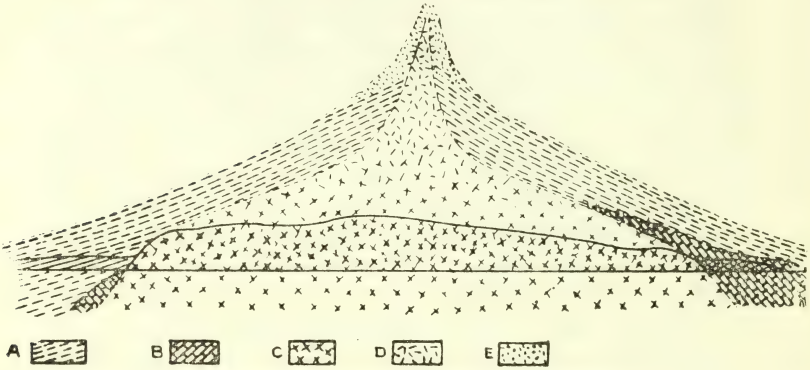
But we can enquire in other directions. We have seen that there is a fairly gradual rise from the outskirts of the granite. This varies in different parts of the Moor, but in the main approximates the six to ten degrees already cited as that of the exterior slopes of volcanoes, until we reach the 1500 feet range. If we take that area contour as representing the base of the central pile or ridge, which would describe an irregular oval some seven and a half miles east to west by fifteen north to south, a slope of thirty degrees on the shorter axis would give a total height of nearly three miles.

To treat the dip of the granite under the marginal rocks as the general slope would imply a regularity of elevation contrary to experience, and involve a theoretical height of at least four and a half miles.

Upon the whole, therefore, I think we may fairly put the height of the central portion of the Dartmoor volcano at three and a half miles, or 18,000 feet. This would involve the disappearance at the peak of more than three miles, or 16,000 feet.

No doubt these are large figures, but they are not by any means exceptional; and the removal of enormous masses of superincumbent rock has to be faced in any event, in order that the granite should be exposed at all. The active presence of a volcano really lessens the amount of work left to be done by the ordinary process of denudation.

Mull is a Tertiary volcano—quite an infant of days as compared with Dartmoor—and its highest point is but 3172 feet.



Diagrammatic Reconstruction of Dartmoor.

It must be understood that this sketch is diagrammatic and has no pretensions to scale, and that it is mainly suggestive and purposely made as simple in its conditions as possible. All below the horizontal line, which represents datum, is purely hypothetical; and all above the curved line, which indicates generally the present surface contour of the Moor and bordering rocks from north to south. This superstructure has been removed. A represents Carboniferous rocks; B, Devonian; C, Granite; D, Felsite; E, Volcanic Material and Ejectamenta. The wedge-like intrusion of the granite has tilted and broken through the upper or Carboniferous rocks, and has thrust as well as heaved the lower or Devonian.

A few moments' consideration will show that if Dartmoor had not some such magnitude as here assigned, it could never have sustained the enormous wear and tear to which it has been exposed. Not a shower that falls or wind that blows upon it but wastes it somewhat; and when we reflect that such degradation has been going on not merely for thousands, but for millions of years, and in earlier days at a much more rapid rate than now, what is left can only be a wreck of what must have been.

The Mississippi is estimated to carry into the sea every year a quantity of sediment equivalent to the lowering of its whole drainage basin by the six-thousandth part of a foot of rock, at which rate the entire mass of North America would be reduced to the sea-level in four and a half millions of years.

Our Dartmoor streams with their rapid fall do proportionately much higher work; and that their volume and activity were much greater once than now, let the great gorges at Fingle, Holne, the Dewerstone, and Tavy Cleave attest. However the rivers may have been helped, to imagine that these ravines were worn by such streams as now occupy them is to assign to our latest geological epoch an antiquity perfectly unconceivable.

Still there are times when even these modern rivers develope a remarkable amount of energy. We may see granite pebbles, two and three pounds in weight, ten or a dozen miles down their courses from the nearest point of origin; and the old beds frequently contain large boulders far more remote. Granite pebbles were discovered on the bed rock of the Laira in sinking for the new Laira Bridge; huge boulders beneath 75 feet of silt at the mouth of the Tavy; and Mr. T. M. Hall records them in the Taw, at Taddiport, twenty to twenty-five miles from a possible source.

A good deal of this rock sculpture may indeed be due to ice action.

> "It is no more possible," recently wrote Professor Prestwich, "to judge of the rate of denudation during the Glacial period by the river and ice action of the present day than it is of the rate of flow of Greenland ice by modern Alpine experience. The enormous pressure and wear of ice 2000 to 6000 feet thick in contracted valley channels . . . the powerful disintegrating effects of extreme cold on rocks, the annual action of ground ice in rivers, and of the sweeping and devastating floods resulting from the melting of the winter's snow and surplus ice, combine to produce results of which it is impossible to judge by the moderate work of these temperate latitudes."[4]

The more severe, however, the degrading influences to which Dartmoor has been exposed, the more important must have been its mass, by comparison with that which remains. We are again and again forced back upon our hypothesis as an *à priori* necessity, for I do not see how any local elevation of the height required could have been other than volcanic.

I do not know a better description of the operation of weathering upon granite rocks than that of Dr. Geikie. He is speaking of Lochnagar, but in its degree the passage equally applies to Dartmoor.[5]

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[4] *Geology*, ii. 553–4.

"Granite . . . is remarkable for the perfection of its jointing, and generally for its toughness. It may crumble away on the surface, but otherwise may remain coherent and durable, though there are some varieties that decay far down into their mass. Its numerous joints, however, afford full scope for the action of frost. On lofty mountain crests, accordingly, granite frequently presents a most impressive array of splintered crags. [Our tors have a more mural character, caused by the horizontal and stratiform jointing,[6] perhaps due in part to the outward slip of the superincumbent rocks.] Pinnacles and buttresses of the most varied forms and dimensions rise along the face of the precipices. Vast rifts, descending for several hundred feet, show where the joints have most easily opened, and naked vertical walls mark where the ice wedges, driven home by the winters of centuries, have at last detached huge slices from the face of the cliffs. . . . Inch by inch the vertical joints are . . . opened further into the face of the cliff. Along the edge one can, as it were, watch all the stages of the process, from the fine rift, just starting like a crack in a window-pane, up to the loosened pillar, which now stands gaunt and alone in front, and awaits the fate that is eventually to hurl it into the gulf below. Far down . . . we can see the grey slopes cumbered with *débris* . . . avalanches of blocks . . . which in the course of ages have been wedged off from the cliffs and are now travelling slowly to the plains, still however a prey to frost and rain, sun and storm, and slowly breaking up into loose fragments as they descend"—the clitters of our tors.

Then there are the milder and more constant influences of aerial and aqueous action combined:

"After weeks of dry weather everything looks baked and dusty. The soil crumbles into powder at a touch. Each fitful gust of wind raises a cloud of dust from the roads, and blows away the sand that has been loosened on the surface of bare rocks. But the sky darkens, and at length rain descends. In a few minutes every channel on the roadways, every gully on the slopes, every runnel and watercourse, is the track of a muddy torrent, which sweeps down into the nearest brook. The brooks, swollen from bank to brae by the sudden descent of such innumerable tributaries, rush along laden with the fine particles of sand and disintegrated rock, which they bear into the main stream of their drainage basin. And the rivers, dark with all this accumulated mud, sweep it downwards into the nearest lake or away out to sea." [7]

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[5] *Scenery of Scotland*, pp. 39, 40.

[6] Hence what have been taken for artificial benches and tables on Crockern Tor.

Before the formation of our present coast line; before the days of our submerged forests, raised beaches, and bone caves; before our Glacial epoch; before the Pliocene and Miocene and Eocene deposits originated; before the Chalk was formed, and the Oolitic building stones were laid down, and huge marine monsters thronged the Liassic seas—long before all these great stages in the world's physical history, the destruction of the great mountain, of which Dartmoor is but the stump, began.

No doubt there were pauses in the operation. No doubt at times it was more rapid and again more slow. No doubt the sea has borne its part as well as wind and rain and ice and snow.[8] But that the rocks of Dartmoor were exposed and broken down to form part of the materials of the beaches of the ancient Triassic sea of Devon, which once stretched at least from Sidmouth to Plymouth, but have been themselves all but wholly swept away to the westward of Torbay, is as certain as that these rocks are as steadily, if less quickly, wasted now. Nor are we without materials for filling up part at least of the interval. The Miocene lake of Bovey Tracey, twelve square miles in area, is a mass of Dartmoor *débris*,[9] brought down by the Teign and its tributaries; and if the other rivers of the Moor then did a proportionate amount of work, we can gain some idea of the enormous quantity of matter removed from its face during that period alone—a mass equivalent at least to hundreds of feet in thickness over the whole of the central region. Nearer to us we have the scraping and scooping of the Glacial age. The evidence for this indeed is inferential rather than direct; but I do not myself see how, apart from ice action, we are to account for some of the expanding hollows and filled-up lakelets along our river valleys, or for sundry of the deposits of clay and subangular stones which not only occupy bottom lands, but coat in so many places the slopes of the granite hills[1] and are frequently cut through in miniature ravines by the brawling little torrents of sudden and heavy rainfall—all indicating an amount of denudation of which the material left behind is a very inadequate gauge.

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[7] GEIKIE, *op. cit.* pp. 20–1.

[8] Rain-wash has played a more prominent part in the modelling of the surface contours of the outer portions of the Moor than is commonly recognised. This is well seen at Blacket, where the Plymouth Lunatic Asylum is being built, on the flank of Ugborough Beacon. The granite in the hill immediately at the back of the asylum is moderately fine-grained, abounding in black mica, and porphyritic. Towards the surface it becomes loose textured and crumbly, and is seen (in a quarry section) to pass upwards into an incoherent mass of granitic sand, which apparently continues until the peaty subsoil is reached. Further investigation shows, however, that the upper part of this sandy stratum is distinguished from the lower by colour-bands indicating a quasi-stratification generally dipping with the hill, but with irregularities which suggest the filling up of hollows; and that this stratified material contains large angular fragments of rock. These are absent from the loose stuff below, in which we recognise disintegrated granite pure and simple. All is granite sand throughout; but while the lower portion is *in situ*, the upper has been gradually washed down the hill, and collected in gullies or hollows—or, where the conditions are favourable, in sheets—to a thickness ranging up to four feet—the solid rock being denuded on the higher slopes of the tor to a similar extent. The quarry where these observations were made is close to the junction of granite and hornblendic slate; and at one point this granitic rain-wash is seen to overlie a subsoil of angular fragments of slate in clay formed by the breaking up of the outcrop of the schistose rocks, and itself showing traces of "hill creep." In more favourable localities the results of such subærial denudation may be very important, so that we need not always call in the agency of constant streams or ice-caps to account for extensive detrital deposits at hill bottoms.

And then we have the remains of old river gravels at high levels along the courses of various Dartmoor streams, with such allied proofs of former waste as we find in the pebble and sand and clay beds of the Hoe (distinctly of Dartmoor origin); in such isolated patches of granitic gravel—the poor remnants of wide sheets—as that of Petrockstow, twelve miles from the nearest point of the Moor; and in the granite pebbles of the Haldon gravel, 800 feet above the sea—each and all themselves but denuded vestiges of the ancient demolition which gave them birth.

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[9] Analyses of natural and artificial china clay give these results:

	Silica.	Alumina.	Potash.	Water.
Dartmoor Kaolin	47·20	38·20	2·0	12·74
Bovey Miocene Clay......	49·60	37·40	...	11·20

[1] So with the granite boulders frequently carried forward a considerable distance over the slates. They are not only remarkable testimonies to the strength of the denuding forces, but of the existence of heights long planed away. In like manner the occurrence of non-granitic *débris* within the granite area recalls the days when the covering rocks stretched up the slopes of the Moorland region far beyond their present limits. The fragmental deposits of the Moor are full of interest.

The Lundy granite is probably of the same age as the Dartmoor, and Professor Prestwich[2] has shown that ten miles of rock which formerly connected that island with the main must have been worn away previous to Pleistocene times. I do not take this as indicating the rate of Dartmoor denudation, for marine waste is one thing, and subærial is another; but it enters into our calculation thus far: it shows that prior to the inauguration of the existing relations of sea and land Dartmoor must have been exposed to denuding influences for a period long enough to enable the sea to do this work.

The volcano of Mull dates only from early Tertiary times—the Eocene; but it has been reduced from 14,500 feet to 3172. The volcano of Dartmoor has probably been reduced from 18,000 feet to 2000; but the additional work bears no calculable relation to the additional time given by its higher antiquity.

COMPETITION AND CO-OPERATION.

SYLLABUS OF LECTURE BY J. C. INGLIS, C.E.

(Read 25th October, 1888.)

Definition and importance of the two terms competition and co-operation. Wealth in the economic sense defined. Wealth involves exchange, and exchange in civilised communities involves money. Exchange essentially involves service for service, and it is put in operation by the idea of advantage which each of the exchanging parties entertain. Competition is the stake produced by several offering and several demanding service or goods. Competition is the free play of all the self interests of which it is the outcome. The relations of buyers and sellers. The relations of buyers with buyers and sellers with sellers. Difference between competition and selfishness. Competition is always welcome between buyer and seller, but not between buyer and buyer and seller and seller. Self interest is the great factor in binding society together, but although it is not the most esteemed impulse of human action that does not prove it is not a very powerful force in social economy. The attitude of Trade Unions to competition. Exchange in labour and commodity operate under the same laws.

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[2] *Geology*, i. 100.

Supply and demand regulate the true value of commodities. What does co-operation mean? and the relations between it and competition? Present relations between capital and labour unsatisfactory. The attitude of Trade Unions to competition. Piecework and industrial partnership the true co-operation. Mr. Babbage's opinions on co-operation expressed in 1870. The probable results of industrial partnership, which have now been well tested in England, France, and Germany. Prince Krapotkine's opinions on the future of industries, especially village crafts. Conclusion.

THE ENGLISH POOR LAW SYSTEM.

SYLLABUS OF LECTURE BY W. ADAMS.

(Read 1st November, 1888.)

Objects of the English Poor Law system. Classes of paupers. Different modes of granting relief. Different modes of training pauper children. Some of the causes of destitution. Suggestions as to the conduct of charity, so as to supplement the work of the Guardians of the poor, and not to encourage dependence, but to assist persons to recover an independent position.

ATMOSPHERIC ELECTRICITY.

SYLLABUS OF LECTURE BY JOHN MERRIFIELD, Ph.D., F.R.A.S.

(Read 8th November, 1888.)

The identity of lightning with spark from the frictional electric machine suggested by Wall and proved by Franklin. Franklin's experiments with kites. His treatment by the Royal Society of England compared with that from France, Italy, and the Continent generally. The danger of repeating his experiments, illustrated by the death of Richmann and effects on Romas. The air is almost always electrified positively. How shown. Times of maxima and minima daily tension. Sources of atmospheric electricity shown to be: (1) Friction; (2) Evaporation of impure water; (3) Combustion; (4) Growing plants. The difference of potential illustrated. What thunder-storms and lightning are. Sir J. Herschell and Professor C. G. Tait, F.R.S., show that the difference of potential necessary for the discharge of a thunderstorm can be accounted for by estimating the number of particles of water vapour in a single inch of saturated steam at about three hundred millions of millions of millions, and that these form but one average rain drop. Rate of lightning, 288,000 miles per second, compared with that of light. Zigzag lightning, sheet lightning, and ball lightning. Periods and localities of thunder-storms. Induction and the return stroke. The pealing and rolling of the thunder explained: (1) by the difference between the rates of sound and light; (2) by the reflection of sound from clouds; (3) by the refraction of sound when travelling through layers of atmosphere of different densities; (4) by the combination of some or all these, with the introduction of forked lightning. The distance at which thunder is heard is proved to be small. Lightning prints illustrated by Mr. Pidgeon's account of a thunder-storm at Torquay, 25th February, 1875. Fulgurites. St. Elmo's fire. Lightning-conductors. Their utility illustrated by the effects produced after their general introduction to Pietermaritzburg, in Natal. The conditions to be observed to secure a good conductor. Laws laid down by the "Lightning-rod Conference."

MODERN THEORIES IN CHEMISTRY.

SYLLABUS OF LECTURE BY LOUIS SEXTON.

(Read 15th November, 1888.)

Modern chemistry the outcome of alchemy. Sketch of the history of alchemy. Its foundations in the various cosmogonies. At first a "sacred art," afterwards an independent study. Its two tendencies leading to the endeavour to transmute metals and to theories of the constitution of matter: the first, the origin of practical chemistry; the second, that of theoretic chemistry. The introduction of the use of the balance in experiments, leading to the discovery of oxygen and to Dalton's law of multiple proportions. Dalton's application of the atomic theory to explain it. Growth of modern chemistry from this time. Re-opening of the old question—What are the elements? Growth of the idea of evolution, as evinced by Prout's hypothesis, Mendeljeef's law, &c. Recent opinion, as shown by Mr. Crooke's address to the British Association, in 1886.

DE RUYTER'S NAVAL OPERATIONS AGAINST ENGLAND.

ABSTRACT OF LECTURE BY W. CECIL WADE.

(Read 22nd November, 1888.)

THE lecturer stated that no full and impartial account existed of these operations as viewed by both countries, and went on to describe the causes of the outbreak of the great war with Holland, which, in opposition to Green, he attributed entirely to the jealousies and rivalries of the English and Dutch West African Companies. The English and German East African Companies of to-day were similarly situated as regarded a possibility of antagonism in the near future. Parliament petitioned King Charles II. to take speedy redress for the losses inflicted on our trade and merchants, and offered to assist him with "their lives and fortunes." Private hostilities of the most pronounced kind were carried on by the rival national companies, until at last the Dutch States ordered their admiral, De Ruyter, to secretly steal away and ravage the English settlements. Giving a brief outline of the previous life of De Ruyter, the lecturer passed on to the declaration of war, and the engagement of the Dutch fleet under Opdam with the English under the Duke of York, at Solebay, which resulted in the destruction of a large part of the Dutch fleet, and death of their admiral, who was blown up with his ship. Then followed a battle of four days' duration between the Duke of Albemarle and De Ruyter, in which the English would have been at last entirely overpowered by superior numbers but for the timely arrival of Prince Rupert's squadron, which ended the fight. In the next battle De Ruyter was defeated off the North Foreland; and the English, under Admiral Holmes, succeeded in burning an immense number of Dutch merchant ships in the Texel, besides burning the large town of Brandaris. Great rejoicings took place at Plymouth when the news of these events reached there. De Ruyter was again fitted out for sea, and sailed with another powerful fleet. In the meantime proposals for peace were afloat, and ambassadors proceeded to Breda, when all at once De Ruyter appeared off the Thames. Charles II., being in want of ready money, had neglected to prepare his fleet for 1667, although possessed of a large number of warships, and having an ample supply of stores at the various chief arsenals at Chatham, Portsmouth, and Plymouth. De Ruyter succeeded in capturing Sheerness, Upnor Castle, and Chatham Dockyard, breaking through the chain at the latter place, and burning or capturing several ships of war which defended it. He then burnt the stores accumulated at Chatham, inflicting a loss altogether computed at £2,000,000. Leaving a squadron at the mouth of the Thames, he proceeded to visit the whole of the south coast, causing alarm and intense excitement for some weeks, and capturing all craft which put out from or tried to make for English harbours. At this time he was styled "Lord of the Channel." He landed a force of 1200 men at Harwich, but retired in consequence of two troops of yeomanry endeavouring to cut off his retreat. He made two captures in Torbay, and threatened Dartmouth, Plymouth, and Falmouth. Finding that the home-returning Virginia fleet had put into Fowey for safety, he resolved to attack them there; but Sir Jonathan Trelawny, at the head of 4000 men, and with 100 guns mounted on shore, gave De Ruyter such a warm reception, that he had to haul off. London remained in a state of panic. Bankers ceased to pay in gold, but offered their securities; the merchants hid their valuables, and sent their families into the country, in fear of the Dutch making a raid on London. All traffic by sea was cut off. This lasted for several weeks, because the Government was powerless to equip a sufficient fleet, and had to concentrate all its efforts in preparing the ports along the coast against surprise. At last came the peace of Breda, which had been long looked for anxiously by the English. The lecturer, commenting on the fact that we had had an almost unbroken series of victories since the great Dutch war, while no foreign admiral of note had arisen to trouble us since De Ruyter, suggested that in this year of Armada celebrations we ought not to forget that England had suffered naval disasters and reverses nearly a century later than the Armada. No Government since that of Charles II. had been so infatuated as to leave England without a first line of defence at sea; but the question was painfully forced upon us to-day by our chief naval experts as to our fitness to hold our own. When three of our chief admirals protest that our navy is in as bad a state as it can possibly be, and that we could not take the initiative successfully in a war with a naval Power like France, it would seem as though a period of infatuation had overtaken all our officials concerned in administering the navy. The lecturer referred to Admiral Symonds's suggestion as to building an additional breakwater outside Plymouth, as the place is now too shallow, and would act as a trap; and also to the Admiral's suggestion for the construction of four large docks at Devonport, and to Lord Alcester's appeal for a large number of cruisers in order to preserve our commerce and imperative food supply in the event of war. He also referred to the defenceless state of our coast ports, excepting the naval arsenals, and pointed to the threats of foreign officers that they would endeavour to extort heavy ransom from our commercial ports, from which there would be no escape if our Channel squadron received a reverse or simply a check. In conclusion, the lecturer remarked that if the lessons of history were to be of any value, we should seek to apply their warnings, where possible, to our own times, and should see that we were prepared in every way to meet an attack at sea, a contingency which might arise at any time, and the issues of which must be of more serious importance to England than to any other Power in the world.

CORAL REEFS.

SYLLABUS OF LECTURE BY G. C. BOURNE, M.A., F.L.S.

(Read 29th November, 1888.)

Various kinds of coral reefs. Fringing and barrier reefs and atolls. Their distribution within the tropics. Their dependence on the temperature of sea water. General characteristics of an atoll: that of Diego Garcia in the Chagos group taken as an example. The characters of the land composing it. The lagoon and its depth; the surrounding sea and its depth. Similarity of barrier reefs to atolls, and of fringing to barrier reefs. Earlier theories to account for peculiarities of atolls and barrier reefs. Those of Chamisso, Darwin, and Dana. More recent views, founded on widely extended researches. The work of Semper, A. Agassiz, Murray, Guppy, and Walther. Upraised coral atolls and their significance. Biological conditions of coral reefs. Growth dependent on biological necessities of polypes. Existence of submarine banks. The possibility of their being raised by globigerina deposits. The first growth of coral on these. The more rapid growth of the peripheral coral stocks. The formation of the lagoon. The centrifugal growth of an atoll. Summary, and conclusion in favour of Murray's views.

THE INFLUENCE OF THE MICROSCOPE ON MODERN MEDICINE.

SYLLABUS OF LECTURE BY W. H. BRENTON, M.R.C.S.

(Read 6th December, 1888.)

GRADUAL perfecting of the microscope. Advances during the last century. The cellular structure of the body. The structure, reproduction, and life history of cells. Schwann's theory of cell formation. Relation of the animal to the vegetable kingdom; of the higher to the lower animals. Modifications of the cell. Terminations of sensory and motor nerves. Lymph stomata. The blood circulation in the capillaries. Characteristics of lymph and chyle, and origin of chyle corpuscle. Absorption in the intestine. Cell exudation in inflammation. Changes in numerical relation to each other of blood corpuscles. The germ theory; origin. Fermentation and putrefaction in relation with micro-organisms. Physico-chemical theory. Position of micro-organisms in vegetable kingdom. Kinds; origin; habitat in nature. Cohn's classification. Immersion lenses.

CALDERON AS POET AND DRAMATIST.

ABSTRACT OF LECTURE BY MISS A. G. COOPER.

(Read 13th December, 1888.)

To estimate Calderon aright it is necessary to begin by a brief sketch of Spain and the Spanish drama.

Spain had passed through a long period of struggle with the Moorish power; had risen to her greatest height, which placed her in the van of European nations; and this pre-eminence was beginning to decline when the subject of this paper appeared. The long crusade against the Moors, which ended in the consolidation of the kingdom of Spain, left ineffaceable marks on Spanish literature, especially on the drama. The strong imagination of an Eastern people lent a peculiarly romantic colouring to the incidents and even to the form of that drama. Spain was still the first power in Europe. Wealth, which seemed inexhaustible, poured in from the rich New World, of which she had still the monopoly. This successful national life bore fruit in literature. The drama especially produced a rich harvest, and—like Athens under Pericles, England under Elizabeth—Spain, when at the height of prosperity, developed a rich and, moreover, national drama. The Inquisition attempted to check the love for theatrical performances, but ineffectually, and Lope de Rueda, in 1540, formed a strolling company, for which he wrote comedies. Lope de Vega succeeded him, and though professing to believe in the "unities," wrote, as he said, "to please the multitude," and in so doing established the nationality of the Spanish drama. The Spanish drama employed as subjects for plays the stories told in the old ballads, and also adopted the old ballad metres. What the *Iliad* was to the Greek dramatists these ballads were to the Spanish. Several attempts were made by Argensola, Gongora, and others to introduce the classic or Greek form, with choruses; but these failed. The Greek dramatists took the *crisis* of a story, whilst the Spanish and English told the whole story, and developed the action and characters, the Spanish being especially strong in plot, and the English in character delineation. It is important to remember this distinction in judging Calderon. Calderon, the successor of Lope de Vega, belonged to what is now called the "Romantic School," and was essentially Spanish; so we must criticise him, not by the classic standard set up by France, which in Europe in the 18th century crippled genius and perverted criticism, but by studying his plays carefully, seek for the cause of his great popularity. The stage in Calderon's time was similar to the English stage of Shakspere's time, and was a rough scaffolding erected at the back of private houses. The royal theatre, however, adopted several improvements.

Calderon, or, to give him his full name, Don Pedro Calderon de la Barca, was born in 1600, the son of noble parents, and destined in infancy for the priesthood. He received a good education at the Jesuit College of Madrid, and the University of Salamanca. His first work was a poem written for the Festival of St. Isidore in 1620. He wrote another in 1622, which received high praise from Lope de Vega. He obtained a post at the Court, becoming a soldier, and served in Flanders in 1625. The King, Philip IV., was passionately fond of the theatre, and secured the services of Calderon to provide plays for the Court entertainments. In 1636 he was made Knight of the Order of St. Jago, and served in Catalonia, where he took his part in suppressing a rebellion. He returned invalided in 1642, and in 1650 fulfilled his mother's wish by joining a religious fraternity. His friend and patron, Philip IV., died in 1666, and Calderon was somewhat lonely in his old age. We know little of his life at this time, but his contemporaries speak of his gentleness and kindness. Boissel, in his *Voyage en Espagne*, published in 1669, gives a somewhat contemptuous notice of him, for the Frenchman looked down on the great Spanish dramatist who was ignorant of the "unities." His death, at the age of eighty, was mourned not only in Spain, but at Lisbon, Milan, and Rome. Calderon describes his own appearance in some lines too long to quote. He had a high forehead, bright eyes, and sweet voice. His portrait hangs on the right of the high altar of the Church of St. Peter, at Madrid.

Calderon's plays are very numerous, amounting, some say, to fifteen hundred. They may be divided into:

1. Secular. 2. Religious.

1. The secular may be subdivided into: (1) The historical; *e.g.*, *The Constant Prince.* (2) Tragedies; *e.g.*, *The Alcalde of Zalamea.* (3) Comedies of the cloak and sword; *e.g.*, *A Man his own Jailer.* (4) Mythological; of the nature of operas, being dramatizations of Ovid's *Metamorphoses.* (5) Martyr plays; *e.g.*, *The Wonder-working Magician*, a portion of which is translated by Shelley. It is said to have given Goethe his idea of *Faust.* (6) Philosophical plays; *e.g.*, *Life is a Dream.*

2. The religious plays, or autos, are peculiar to Spain, and were employed to represent theological dogmas, or, as in the autos sacramentales, the mysteries of the eucharist, or were ethical.

They were a further development of the mystery plays, and were sanctioned by the church. Calderon wrote several—*e.g.*, *The Theatre of the World*, *The Poison and the Antidote*—but their subjects, being religious, cannot be described in these pages. Shelley speaks with rapture of the "starry autos" of Calderon, and Schlegel describes enthusiastically their beauty and religious feeling. Calderon's skill as a dramatist consists chiefly in his wonderful power of plot construction. Schiller and Goethe speak admiringly of this power, which is indeed fully admitted by all who have any knowledge of his works. His characterization is not equally strong, though in one play he shows that he does possess it in a marked degree. In the *Alcalde of Zalamea* we have Crespo and Don Lope depicted with clear lines, and they stand out as real men. In other plays his characters are rather types than individuals, and are drawn from the artificial life of Courts.

Calderon never employs prose, but the great variety of metre which he uses prevents monotony and illustrates changes of thought and feeling. The use of assonant as well as consonant rhymes allows greater freedom than English poetry admits. The plays are all divided into three jornadas or acts. The Spanish language lends itself to grandeur of thought. This "most stately of the daughters of Latin" is at her best in Calderon's plays, though we must miss much of the beauty when in English dress. The stories which Calderon presents to us in dramatic form are beautified by his poetic conception of life, his brilliant imagination, and high-toned thought. Life is idealized, and this idealism is a pleasant and refreshing thing in these days of realism, offered in modern plays and novels.

Our poet revels in Nature and her varied beauty, and we feel this in his writings—so full of descriptions of natural beauty on land and sea. His imagery is rich and varied; in fact, almost prodigal. He rises above national prejudices, and gives honour to the Moorish heroes of his plays.

SOME OBSERVATIONS ON THE PRESENT STATE OF TECHNICAL EDUCATION.

SYLLABUS OF LECTURE BY C. S. JAGO, F.R.G.S.

(Read 20th December, 1888.)

1. Introduction. 2. What has been done. 3. What is now being done. 4. Cause of the present public feeling. 5. Consideration of its reasonableness. 6. Influence of labour on education, and *vice versa.* 7. Age and status of students. 8. Relations of primary education and technical work. 9. Comparison of English technical instruction with that of other countries. 10. Is technical education to become general? 11. Science and art work in Plymouth; proposed new Jubilee building. 12. *Resumé* and conclusion.

CONVERSAZIONE.

(3rd January, 1889.)

An account of the proceedings at this Conversazione will be found among the Reports.

THE MACKEREL FISHERY.

BY B. RIDGE.

(Read 10th January, 1889.)

It will be remembered that in a paper I read before this Institution on "The Western Fisheries" I referred to the mackerel fishery as being one of considerable importance in this locality, and from very early times. The common mackerel is the sort with which we are most familiar on this coast. It frequents the British seas at different times of the year, and constitutes a well-defined family form. Of the various kinds of food-fishes caught around our coast, probably none are more interesting to the naturalist, and very few of more importance for food.

The mackerel being a wandering tribe, considerable uncertainty has always been experienced in their visits to our shores, and no two seasons are ever alike. It is generally considered that the greater portion come from the Atlantic, which probably explains why the West of England has been favoured with a larger quantity of these dainties than other parts of the British coast.

As they are a surface fish, they are caught by the seine net and the drift net, and a few by hook and line. By far the greater quantity, however, are caught by the drift net, and this means was well known to fishermen in very early times.

The construction of the mackerel seine only differs from the herring and pilchard seines as regards the size of the mesh and depth of the net, the material being the same. Sixty years ago the wives and daughters of the fishermen used to make the twine for net-making, which was of hemp; and I can well remember that at various Cornish villages interested in the fishery the whole of the mackerel nets were made by hand in the homes of the fishermen by their own families. This important part of fisher life has almost died out, owing to the introduction of net-making machinery, and at present the repairing only is done, chiefly by the female relatives.

When the very old fishermen were in the heyday of their calling, the boats in use were three-mast lugger-rigged (especially those of Mounts Bay), of thirty feet to thirty-four feet keel—open boats with sharp stern—quite a unique type, a *fac-simile* of those now used by the fishermen of Brittany, possessing exceptional sailing qualities. I have heard old salts recount with considerable glee an occasional chase after them by a Government cruiser (for they were often suspected of running the gauntlet with contraband goods on board), and if it was a turning to windward the Revenue cutter generally got the worst of the chase.

In my paper on the "Herring Fishery" I mentioned that at Great Yarmouth the herring fishery was carried on to a greater extent than at any other port in England. I find that in the year 1825 no less than £17,000 was earned by the Yarmouth mackerel boats. The fishing was carried on during the months of May and June, and the rig of the boats was precisely the same as that of boats in Mounts Bay, though very much larger. In 1853 no less than ninety boats were engaged in catching mackerel there, probably as large a fleet as at any port in England, and the total earnings that season were £27,000. Since then, however, up to within the last ten years the Yarmouth mackerel fishery nearly died out, the mackerel ceasing to visit the coast in quantity; and even to-day there are not probably more than twenty Yarmouth boats engaged in fishing for mackerel.

In turning to Lowestoft, however, only thirteen miles apart, the very reverse of this is seen—a score of mackerel boats has increased to 120.

In prosecuting the mackerel fishery the difficulty of meeting with fish is greater than in fishing for ground fish. At present our Plymouth boats are working from twelve to twenty-five miles S. and S.S.W. of Start. We have about 250 boats night after night trying to capture the mackerel, but seldom more than a sixth of the fleet are successful during this time of the year; whereas during the months of April, May, June, and July the fishing becomes more regular, and the chance of earning money not so uncertain. If there is any such thing as luck in fishing, it certainly is now. It often happens that one boat will haul in £50 or £60 worth, while scores of boats on the same ground will get nothing.

A practice prevails just now, which was almost unknown to the old men in their young days, of "briming" for mackerel. The ordinary method is to put the nets in the water just about sundown, and to drive with the tide say till 10 or 12 o'clock, and then get the nets on board again, and return to harbour with the result (if any) of these labours. But in consequence of the fish being so shoally during this time of the year, it is the custom to sail about and search for them in the water, and then shoot the nets upon them, and so capture them. This custom has, however, a very expensive result, and one that is giving some trouble.

Mackerel are surface fish, and therefore to catch them by the drift net the net is so arranged that the top part floats on a level with the surface of the water. Hence any passing vessel crossing over them is sure to do considerable damage, and as at present boats go on "the brim" (or sail about) in search for fish night after night, there is a kind of mutual destruction going on, every crew complaining of nets being cut, and every crew just doing the same thing.

"Necessity is the mother of invention," and within the last three weeks there has been a wholesale alteration of this matter, by crews so arranging their nets that when put in the sea they sink some four to six feet deep. It is generally considered though that not so many fish are caught by sinking the nets this depth.

The mackerel net of West-Country fishermen is generally 65 yards long to rope, 24 meshes to the yard, and 140 meshes deep; 50 nets to each boat. It is made of cotton. East-Coast boats have their nets shorter, about 25 yards long, 28 to 30 meshes to the yard, and 200 nets to each boat. The West-Country boat is usually lug-rigged; the East-Coast boat dandy-rigged.

The times of operation are as follows: *January.*—Fishing goes on from off the Start 25 miles to Eddystone. *February.*—Generally falling off. *March.*—South-west of Start to south of Eddystone. *April.*—Lizard fishing begins five to ten miles south to west; also off St. Ives, and south-west of Eddystone, and off Falmouth. *May.*—Mounts Bay boats put on board large mesh nets, and go on ground off Scilly, where large fish are fallen in with 100 miles west-north-west of Land's End; green water. Lowestoft boats continue to find fish in Mounts Bay, but not so large as off Scilly, and evidently not the same fish. *June.*—Continuation off Scilly and in North Channel by St. Ives boats. *July.*—Fish become shotten, and come to land again; quantity less, and fishing closes in West of England. On East Coast for short time fishing sets in, but very irregular; of a very superior quality, and very rich. This is generally termed Midsummer voyage. *August.*—Off Plymouth, inshore fishing. *September.*—East Coast for five weeks, when a considerable quantity is generally secured. *October.*—Occasionally Mounts Bay and off St. Ives; not a regular fishing.

I have already said that mackerel are considered a very wandering tribe, and that their visits to our shores are very uncertain. This holds good rather in connection with the fishing going on at present off our own coast. For instance, during last week good fishing (comparatively) took place on Monday, Tuesday, and Wednesday nights, but on Saturday it fell off considerably. On Monday of this week twelve boats landed from 4000 down to 1000 per boat. A very large fleet went off on the same ground on Monday night, and the result was that the majority of the boats had not a single fish, and the remainder only very few per boat.

The wind had been prevailing north-east to north during the few good nights' fishing. On Monday, however, the barometer began to fall, and during Monday night it came on stormy weather, with the wind south-east. With this shift of wind away went the fish. The question is, Where, and why? My own opinion is that the fish went down in deeper water because their food went down first.

I have said that off the East Coast a very respectable fleet of boats fish from Lowestoft during September and part of October, and that considerable quantities have been caught from year to year. The result of 1887 was something like £27,000. The proceeds of 1888, however, were not more than £2000; in fact, an almost complete failure. It is noteworthy that during the month north-east winds prevailed, the temperature being very cold, and the fish did not strike the shore. Probably they passed by the coast on to Ramsgate, their usual course far off the shore in deep water.

During May, north-west of the Land's End 60 to 100 miles, fish are always found in green water. In getting into this ground different coloured water will be passed; but so sure as the green water is met with, fish are there. The interesting point here is, What causes the water to be green? and why are fish found there with such certainty? Food again, I feel certain, is at the bottom of this.

Formerly the greater part of the fish were sold locally, especially during May and June; but during the spring, especially in Lent, considerable quantities were sent by coach to Bristol, Bath, Birmingham, and London, and cutters were employed to run from Mounts Bay to Portsmouth, Bristol, and Swansea, which were the principal markets then. As the railway system came west the old methods of transit soon passed away. No section of our local industries has been more directly benefited by the railway system than have our fisheries, though there is more room for improvement in this direction. Of course every trader knows that railway rates are vastly too high, and ought to be lowered. Before the railway system markets for mackerel were limited; now, however, there are plenty of places to send them to. The larger towns are by far the best markets, and on the whole London stands first, except it be from now till the end of Lent, during which time our neighbours across the water, Paris especially, compete with London.

In this connection it is important to note the very great benefit which the English mackerel fishery has received by the Treaty of Commerce between England and France of 1860, and especially during this particular time of the year.

Were we to go back to the state of things before 1860 the fishing interest in this particular would be seriously affected, and the mackerel fishery of the West of England at this season of the year would not pay for working.

The principal mackerel season for the West of England is from April to June. The use of ice in warm weather is very beneficial, and with quick despatch by rail fish in good condition can be delivered to all the important towns of England and Wales.

Boat owners are keeping pace with the times in fitting their boats out on the most approved principle; and steam capstans for hauling the nets on board are gradually replacing the ordinary hand capstan. Larger boats too are being built as the older ones get laid up, with excellent accommodation both for the general work and also for the crews themselves. They are most excellent sea-boats, and sail remarkably fast.

The Duke of Edinburgh, in a paper which the Prince of Wales read for his brother during the late International Fisheries Exhibition, paid a well-deserved compliment to the admirable sea-going qualities of the Cornish lugger-fishing boat, and said that he knew of no class of fishing craft of like size that surpassed these luggers for speed and stability combined.

On November 14th, 1854, the fishing lugger *Mystery*, of Newlyn, Penzance, of 36 feet keel, was fitted out and manned by Richard Nicholls (master), Job Kelynack, Richard Badcock, William Badcock, Charles Boase, Philip Curnow, of Newlyn, and a Penzance man named Lewis, who was shipped as cook and steward. Her port of destination was Melbourne, Australia, which she reached with the mails from Capetown March 14th, 1855.

Plymouth has ever been a central port in connection with the mackerel fishery, and to-day is still in that proud position. At present the whole of the fleet from Mounts Bay are here fishing, bringing in the wealth of the Channel as best they can. Many boats from Newhaven, Shoreham, Hastings, Brighton, Lowestoft, and Great Yarmouth are here, and more are coming. When they are all here not less than between 300 and 400 boats will be using the port, averaging at least seven men to each crew, or 2800 or 3000 persons. The presence of these, with boats from Looe, Mevagissey, &c., besides our own Plymouth boats, will give you some idea of what benefit or otherwise to themselves and families, as well as to the town, a successful or unsuccessful mackerel season will be.

So far as harbour facilities and landing accommodation in connection with the growing needs of the fishing industry of the West of England are concerned, till within the last three years practically nothing worth naming has been done to meet the wants of the trade; and scarcely any place is in a worse plight than Plymouth so far as landing and despatch is concerned.

THE MAKING OF THE ENGLISH NATION.

ABSTRACT OF LECTURE BY REV. W. BINNS.

(Read 17th January, 1889.)

The lecturer said he implied by the English nation the peoples of Great Britain and Ireland, those whose language was practically universal. There were a few Irish, a few Welsh, and a few Highland Scotch, to whom English was nearly, if not altogether, an unknown tongue. These were the survivals of primitive races not yet entirely incorporated with the organism of English civilisation, and might be called the undeveloped members of the one community. There were men in Britain in pre-historic days, fabulous centuries, it was believed, before the times of Herodotus and Moses. At the close of the glacial period men were living in the valley of the Thames, who were gradually destroyed as the climate became either more temperate or arctic. Following these were the Cave-men, whose nearest kin were the modern Esquimaux. As the climate changed to a more equable temperature, the Neolitic men arrived, and with them the dawn of civilisation. Finally, but still in pre-historic days, perhaps some centuries before Christ, Britain was invaded by the Aryans from central Asia, and the Iberians, whom the former overcame, and with whom they commingled blood; the joint race produced being of a finer type than either race was capable of producing by itself. It was impossible to fix more than an approximate date for the migration of the Celts into the British Isles. The Galli and Belgæ of Cæsar appeared to have been of Celtic stock. The notion that the ancient Celts were mere painted naked Britons was a popular delusion. Long anterior to the futile expeditions of Cæsar allusions to them by early Greek and Roman historians showed that they must have been far above the level of barbarians. Himilcar, the Carthaginian, penetrated beyond the Pillars of Hercules, and found the Britains a numerous race, endowed with spirit and dexterity, and all busy with the cares of trade. On the authority of Pliny, this voyage occurred when Carthage was at the zenith of power, about 240 B.C. Before the blood and life of Rome had entered on the historic stage, the inhabitants of Britain were an agglomeration mainly of Celts, belonging to different tribes, but possessing unity of race, and incorporated with them were the Iberians, together with some wandering Phœnicians and Carthaginians, and probably some Greeks. According to tradition there were also Jews in Cornwall, though as to this there was great doubt. The Jews, however, did begin to scatter themselves before the Roman occupation, and it was quite possible that some might have wandered to this island. From the first arrival of Julius Cæsar to the final departure of the Roman legions was a period of 480 years, during 350 years of which period Britain was a Roman province. Between Cæsar's own legions and the Britons the distinction was more in manners than in blood, the soldiers being chiefly Celts and Gauls. It was probable, therefore, that the influence of the Romans on the original stock was to an inappreciable extent. Not so with the actual Roman conquerors of Britain later on, who settled in the country, and after whose advent the pure-blooded Briton disappeared. In their place arose a mixed race of Britons and Romans—a race in which the Romans did not absorb the British, but in which the British absorbed the Romans. The Romans contributed to the language of the natives without changing or revolutionising it, and, above all, brought to this country the literature, politics, and religion of Rome. Within 200 years after the departure of the Roman legions Britain became the England of the Celtic-speaking people, excepting the districts of Wales and Cornwall, the kingdom of Strathclyde, the Highlands of Scotland, and Celtic Ireland. Passing then to the historical period in which Britain first assumed the name of England, and the invasions of Hengist and Horsa, when the Britons were exterminated or driven far into the west, the lecturer came to the period of the Norman invasion. Unlike the Romans, he said, who only introduced a few Latin words into the British language, and left it substantially as they found it, the Normans gave their language as well as their name to the country of their adoption. But English did not destroy the British, for the names of numerous rivers, mountains, and towns, remained as they were, and hundreds of our modern household words bore a distinctly Celtic parentage. The English took over as much of the Celtic language as they cared to take, and settled amongst the Celts as a ruling aristocracy at first, though time brought a closer union. Celts and English merged into one people, the English bringing with them township life and government, and the germs of trial by jury and representative institutions. Our literary history started absolutely with them, and our religious history with them made fresh beginnings. By the middle of the seventh century the English people were constituted, and since that time they had gathered into themselves men of many nations and of many languages. Though their own language remained English, the largest proportion of the blood was Celtic. Edward III. settled colonies of Flemish weavers in Norfolk, Suffolk, and Essex. Large numbers of Huguenots fled to England after the massacre of St. Bartholomew; Dutchmen came with William of Orange, and Germans with the house of Hanover. Jews had always been coming, revolutions had brought refugees, the opportunities of commerce tempted many, and the general mixing of races which the Celts began went on still. In the words of Wordsworth, we English people

"Who speak the tongue that Shakspere spake,
In everything are sprung of earth's best blood."

It was doubtful whether any persons of pure blood were left amongst the English; any pure Celts, pure Teutons, pure anything except what we called English. The English were mongrels, and were the better for it. The words in Defoe's vigorous satire, that "those nations which are most mixed are the best," well interpreted the splendid part that English people had played in the historic drama of world-life. Where the Celts had been isolated, they had failed anywhere to establish a flourishing national life of the modern type. The Celts of the Highlands and West Britain or Wales would offer no serious difficulty to the amalgamation of all in one which was bound to happen hereafter. The stream of tendency, ever since the English settlement, had flown steadily and irresistibly towards unity of government and a common language. Unhappily the Irish Celts cherished an antagonistic feeling against the English settlers in the island for a longer period than their kindred in the larger island of Britain. But patience and firmness, justice and generosity, would ultimately lead to a closer union. The English nation, composed of many peoples, had grown into manhood through the storms and conflicts of a thousand years, and their advent was prepared for thousands of years before.

HOW TO BRING ABOUT THE MILLENNIUM.

SYLLABUS OF LECTURE BY GILBERT SLATER, B.A.

(Read 24th January, 1889.)

How to bring about the millennium means, if considered a question in economics, how to abolish poverty and hard times. Hard times explained as a consequence of our currency system. Mr. Marshall's remedy. Poverty of the majority of the population a necessary consequence of the law of wages under free competition, and not to be prevented by thrift and temperance of the workers, by limiting the population, by trades' unionism, nor by co-operation and profit-sharing. Recent action of the London School Board and County Council, in boycotting employers that do not give fair wages, recommended as an example to be followed; such action, carried as far as possible, might do much to diminish poverty; if not, the only means left seems to be Socialism. A possible Socialist programme sketched. Prospects of Socialism in England briefly considered.

LIVE-BURIAL.

SYLLABUS OF PAPER BY W. J. SQUARE, F.R.C.S.

(Read 31st January, 1889.)

Introductory remarks. Dread of live-burial common to all ages and countries. Directions given by will and otherwise for the mutilation of the body before interment, to ascertain the certainty of death. Narration of a remarkable case of live-burial as reported to the lecturer. Other cases of reported live-burial. The signs or evidences of actual death. Precautions taken by ancient and modern nations to ascertain the certainty of death, including certain religious usages relating to the subject. The precautions employed in France and England for that purpose, with especial relation to the registration of deaths and coroners' inquests.

STRINGS.

SYLLABUS OF LECTURE BY ROBERT SMITH.

(Read 7th February, 1889.)

INTRODUCTION. Strings the most useful and general means for producing musical sounds. Different modes of string-vibration: A, longitudinal; B, transverse—(i.) entire, (ii.) sectional. Experiments. Influence of sounding-boards. Different methods of exciting string-vibration—plucking with the fingers; plectrum; percussion; air-currents; friction. Bowed instruments. Conclusion. This lecture was illustrated by an extract from one of Beethoven's string quartets, in which the following kindly assisted: Messrs. J. Pardew (violin), W. Wingate (viola), Frank Reed (violoncello), and Miss Theresa Meeres (violin). Specimens of local handicraft in violins, violas, and violoncellos, and several valuable old instruments, kindly lent by Mr. Pardew, Mr. Codd, Mr. Weekes, Dr. Meeres, and others, were exhibited.

THE EDDYSTONE: FACTS AND FICTIONS.

BY H. B. S. WOODHOUSE.

(Read 14th February, 1889.)

The fact that no paper upon this subject has hitherto been laid before the members of the Plymouth Institution may perhaps be thought a matter of surprise. It must, however, be presumed that the earlier adherents of the Society were so familiar with all that could be said about it, that the desirableness of bringing it forward never entered their minds. When the town of Plymouth occupied a space only a little more extended than that which was contained within the compass of the walls which enabled its inhabitants to stand the assaults of the besiegers for no less than three years in the middle of the seventeenth century, the number of residents who did not know all about Smeaton's Lighthouse must have been few indeed. His building had only been erected some fifty-five years at the time this Institution was founded, and Plymouth not having become so much of a health or pleasure resort as since then, strangers formed but a small proportion of the population. Moreover, most of her adult inhabitants were then connected with the trade and commerce of the port, or with its shipping; so that those who required to be told anything about the lighthouse, or the reef on which it was built, and the purposes for which it needed to be placed there, would be very few. There are now, however, doubtless many living in the enlarged Plymouth of to-day, who have not had the occasion, or perhaps the opportunity, of making themselves acquainted with the subject, especially as regards events prior to the date of Smeaton's work.

This must be my apology for introducing the subject, and my excuse for mingling general facts, of which most of the members are aware, with others which are not so well known.

Notwithstanding the necessity of including well-known details, I have thought it best to present the subject in something like chronological sequence.

To mariners the *position* of the Eddystone group of rocks (the gneiss of geologists) in the open Channel, nine or ten miles away from the nearest point of land, and in the direct track of homeward-bound vessels, constitutes it a very special danger. Add to this that the various reefs stretch under water, at only a slight depth, for distances varying from a few hundred yards to nearly a mile, and that the natural slope of the rocks is towards the south-west, and it must be apparent (the prevailing winds blowing also from that quarter) that the waves are driven up the slope with constantly increasing force, until by the time they reach those peaks which are visible at low-water, and which are scattered over an area of about half an acre, they have acquired an almost resistless power.

Robert Mudie says that they "lie near the point where the strongest eddy of the bay holds conflict with the tide round the Lizard;" and an officer of the Trinity Corporation, writing of them in *Good Words* for 1882, points out that the dangers, even in moderate weather, are increased "by the uncertain, conflicting, and eddying movements of the tides" among these reefs, which he proceeds to say, "have always been sadly bewildering to mariners not familiar with the locality."

It is no wonder then that sailors, whose lot was cast in days before a warning light was placed upon the Eddystone, should have regarded it with such dread. With those who were homeward-bound it was such an object of terror that, in the words of Smiles, "They were so afraid of running upon it unawares, that they entered the Channel on a much more southerly parallel of latitude than they now do, and in their solicitude to avoid this danger they too frequently ran foul of another, and hence were often wrecked on the French coasts, and more particularly on the dangerous rocks which surround the islands of Jersey, Guernsey, and Alderney."

I have endeavoured to ascertain when these dangerous rocks were first mentioned in history, but have not yet succeeded in finding any earlier reference than that contained in William of Worcester's *Itinerary*, of the journey undertaken by him in the year 1478. This *Itinerary*, which was given to the public by Nasmith in a volume published in 1778, was written mainly in Latin of a quaint sort, and the original MS., preserved in the library of Corpus Christi College, Cambridge, was kindly examined for me two years since by the courteous librarian, the Rev. S. S. Lewis, F.S.A. As regards the portion I am about to quote, Mr. Lewis says that the transcript from Nasmith (which was sent to him for verification) "has faithfully reproduced William of Worcester's spelling throughout."

In his MS. William groups together the information which he obtained from his own observation, and from well-informed persons whom he met, and places it under various heads, as Rivers, Islands, Towns, &c.; and among the *Islands* connected with Devon and Cornwall he thus describes our subject: "Insula parva, anglice a rok, vocata Edestone," &c.; or, to give it in Mr. Worth's translation, as published in the *Transactions of the Devonshire Association* for 1886: "A little island, in English a rock, called Eddystone, is situated south and north opposite to Plymouth, otherwise called the foreland of Rame open upon Plymouth, and it lies about fifteen miles in the narrow sea" (off).

The next reference to that of William of Worcester appears in a work preserved in the Bodleian Library. It is entitled a *Safeguard for Sailors; or, The Rutter of the Sea*, by Robert Norman. It was published in London in 1584, and describes the reef as "a rocke which is called Edie-stone, and it lies south-west southerly from the Howe of Plimouth."

Camden in his great work, the *Britannia*, the first edition of which was published in 1586, is the next to notice the Eddystone. Its dangerous nature is well recognized by him, for he characterizes *Ideston*, as he calls it, together with *Long shippes*, as "Scopulos potius infames quam insulas," &c., which Bishop Gibson translates as "rather *infamous rocks* than islands."

This brings us very near to the great event in English history, of which the Tercentenary was so widely celebrated last year, and a worthy memorial of which will soon grace our Plymouth Hoe. Of the various genuine accounts of the events which happened during the opening days of the conflict, the earliest is that entitled, *A Discourse concerninge the Spanish Fleete inuadinge Englande in the year* 1588. The original of this was written by Petruccio Ubaldino, of Florence; and when translated into English by A. Ryther, was published "at his shop, being a little from Leadenhall, next to the sign of the Tower," in the year 1590. A copy of this work forms part of the second volume of the

Harleian Miscellany. It may be interesting to quote a little from this almost contemporary account.

It mentions the advice received by Lord Howard, that the Spanish fleet had been sighted off the Lizard by Captain Fleming; not the casual discovery by a pirate, for he had been deputed by the Lord High Admiral to watch for their coming. The English, being thus aroused, lost no time in getting their vessels to sea; and on June 20th, as the *Discourse* proceeds, "the Spanish fleete being manifestly discouered about a hundred and forty miles from Edestone, and cleerely seene of euery one toward the west, and so far off from Foye as the English fleete was, that is twenty-five ordinarie English miles," was soon found to be disposed in the form of a crescent moon.

In another work of about the same date—the *Expeditionis Hispanorum in Angliam vera Descriptio*—the Eddystone reef is shown and named in five out of the eleven charts of which the book consists.

It is somewhat surprising that our existing naval records seem to have no mention of the numberless cases of wreck that must have occurred on the Eddystone in early times. Professor Laughton, to whom I applied for assistance in tracing any such, replies that he is not aware of any instance of a ship-of-war being lost there. Hakluyt, however, writing in 1599, speaks of a storm which befell the Earl of Cumberland's expedition to the Azores in 1589. Returning with some ships which they had captured, one of these prizes "suffered shipwracke at a place vpon the coast of Cornwal, which the Cornishmen cal Als Efferne, that is, Hel-cliffe. But the Admirall [of the Spaniards that is] was sunke with much leakinge nere to the Idy-stone, a rocke that lieth ouer against Plimouth Sound, and the men were saved."

We hear little or nothing of the reef during the next century. A few sets of charts, published within that period, note its position. Chief among them must be mentioned Sir Robert Dudley's great work, the *Arcano del Mare.* Having been a naval commander and explorer before the time of his enforced retirement from England, he brought out the *Arcano* in 1646 at his own expense. At this time he was seventy-two years old, and was residing in Tuscany; and the book contains a great number of accurate and valuable maps, in one of which the "Ediston" is shown.

During this time, however, we have the first *local* reference to the reef. It occurs in a letter from Mr. Thomas Crampporne to the Admiralty, dated 20th July, 1636. In this epistle the Mayor of Plymouth—for such was the position Mr. Crampporne then occupied—draws the attention of the Admiralty to the operations of the Sallee rovers, who then infested the Channel, and mentions expressly that "two fisher boats had just been captured near the Edyestone."

Our next contemporary references will be to matters in which the Corporation of Trinity House was concerned.

In 1623 Sir William Monson, while writing concerning the need of a lighthouse at the Lizard, says, "I saye the like danger is in haylinge in wth the Boult, in respect of the Edistone, that lyeth more dangerously than the Gulf." The first proposal for erecting a warning light upon the Eddystone itself seems to have been made in 1664. In this year Sir John Coryton petitioned the Trinity House, along with Mr. H. Brunker, for leave to erect lighthouses at Scilly and Eddystone.

As was customary then, an adverse report was made when this petition was submitted to the Corporation by the Duke of York, and we hear no more of the proposal for thirty years. The Corporation, so far as the erection of lighthouses went, seem to have been always in "the cold shade of opposition," the principal reason for which we may judge to have been the fact that if they attempted to erect lighthouses under the powers of their Act of Elizabeth, that statute obliged them, or seemed to oblige them, to do so at "their own costs." Nevertheless, the numerous cases in which the *objectionable burden*, as they reckoned it, of a tonnage upon passing ships was, in spite of their protests, laid upon shipowners and merchants, for the benefit of private owners of beacon lights, seem about this time to have made them somewhat wiser.

Mr. E. Price-Edwards, in a capital article in *Good Words* of 1882, thus speaks: "This Corporation feeling the influence of public opinion in regard to the marking of the Eddystone, resolved to make an effort to have it indicated, and with that object obtained a special Act of Parliament in 1694."

Now before I saw this article I had received the assistance of a gentleman in London in looking up this subject, and he had searched especially for any Act of Parliament authorising the erection of a lighthouse on the Eddystone. Of course, he very quickly found that the second lighthouse was built under powers conferred by an Act, but there seemed to be no trace of any in relation to the first.

I accordingly wrote direct to Mr. Edwards, and asked him to point out the Act to which he had referred in his article. In reply he acknowledged that "the expression, 'Act of Parliament,'" was "inaccurate;" and said, "It is very difficult to decide, owing to a great many of the records having been destroyed by a fire at the old Trinity House in the latter part of last century. But a royal grant was probably made in 1694, and the immediate authority for setting about the work was probably found in the 8th Elizabeth."

For the discovery of the patent, under which the Corporation acted, together with a great deal more of the information embodied in my paper, I must acknowledge my indebtedness to Dr. H. H. Drake. My great difficulty throughout has been my own lack of opportunity for searching into original records; and had it not been for the very kind assistance of this gentleman, Mr. J. Brent, Mr. W. H. K. Wright, and many others, I could not have ventured to have written this paper.

Having obtained a transcript of this document, which was dated at Westminster the 22nd June, 1694, I will lay before you its principal provisions.

PATENT ROLL.

6 WILLIAM AND MARY. PART 5, NO. 15.

WILLIAM and Mary by the grace of God etc. To all to whom these presents shall come Greeting. Whereas the Master Wardens and Assistants of the Trinity House Deptford Strond by their humble Petition have represented unto us that Application hath been made to them by the masters and owners of Shipping trading to all parts Westward of Plymouth as appears by those numerous Subscriptions already made and ready to be produced to erect a Light house or Beacon with a light upon the Rock called the Eddystone off Plymouth harbour in the County of Devon or Cornwall as safe direction for ships hereafter to avoid that dangerous Rock upon which the lives of so many of our good Subjects have perished, and that in consideration of the vast charge and hazard of such an Undertaking the said masters and owners do voluntarily offer and agree to pay to the said Master Wardens and Assistants after the same rate and proportion, they now do to the light upon Dungeness viz One penny ꝑ Ton outward and the like inward for all ships and Vessels passing by the said lighthouse (Excepting Coasters who are to pay but twelve pence ꝑ voyage), and the Petitioners being on due Inquiry and consideration well satisfied that the placing and maintaining a light upon the said Rock will be of great use and benefit to Navigation in General and to our own Ships in particular have humbly prayed us in consideration of the Charge of erecting and maintaining the said Light house or Beacon with a Light to grant them our Letters Patent for their demanding and taking the Duty of one penny ꝑ ton outward and as much inward from all ships and vessels passing by the same (Coasters as aforesaid excepted) the said payment to commence upon kindling the light.

Now know yee that Wee for the Consideration aforesaid of our especiall Grace certaine knowledge and meer motion have given and granted and by these presents for us our heires and Successors doe give and grant unto the Master Wardens and Assistants of the Guild Fraternity or Brotherhood of the most Glorious and Undividable Trinity and of Saint Clement in the Parish Church [*sic*] of Deptford Strond in the County of Kent otherwise called the Master Wardens and Assistants of the Trinity House of Deptford Strond their Successors and Assignes full and free liberty licence power and Authority that they or any of them shall and may demand Collect and take of the Merchants and Owners of Shipps Hoys and Barks which shall passe by the said Light house intended to bee Erected on the said Eddystone as aforesaid the Duty of One penny ꝑ Tunn outward bound and alsoe one penny ꝑ Tunn inward bound (that is to say of the merchants one halfe penny and of the owner of Shipp Hoy or Bark an halfe penny) and of such Strangers Shipps and Vessells as shall happen to pass by the said Light house or Beacon after the like rate if they shall put into any Port or Harbour although they doe not or shall not unlade or discharge any goods there. Excepting Coasters from whom we doe hereby for us our heires and successors give full power and Authority unto the said Master Wardens and Assistants their Successors and Assigns to demand Collect and take twelve pence for each Voyage passing by the said lighthouse or Beacon and noe more.

To have hold receive and enjoy the said lycence liberty power and Authority and other the premisses herein before mentioned and intended to be hereby granted unto the said Master Wardens and Assistants and their Successors from the kindling of the said light during the continuance thereof.

And forasmuch as other Order cannot well be taken for the levying of the said Contributions for the effecting establishing and continuance of this good Work then in the Ports Roads Creeks Harbours and Havens unto which the said Merchants and

Marriners doe and shall Trade and arrive, Wee doe by these presents for us our heires and Successors ordaine and appoint and alsoe strictly Charge and Command all and every the Customers Collectors Comptrollers Surveyors Searchers and Waiters and theire and every of their Clerks respectively Within the Port of London and other our Ports and all Captaines Lieutenants and other Officers belonging to any Forts Castles. And alsoe all Wardens Port Reeves and Keepers of any of our Ports Harbours and Havens, and all Wharfingers Porters and labourers belonging to the Waterside and all other the Officers of the Customes to us our heires and Successors now being and which for the time being hereafter shall bee in our Ports of London and in all and every the Ports Harbours Roads Creeks and Havens and places within our Realme of England to whom it shall or may appurtaine. That they or any of them at any time hereafter doe not nor shall not take or receive any entry or Cocquett or give make or certifye any Cocquett Returne Victualling Bill or Discharge or permitt any Goods or Stores to be laid on land or discharged or shipped from or on any Shipp Hoy Bark or other Vessell either Stranger or English lyable or subject to the payment of the said duty to pass by or from you till payment bee made of the said Duty upon Payne of our high displeasure and such Punishment as by the Laws and Statutes of this our Realme may be justly inflicted on the Offenders for such their contempt and neglect of our Royall Will and Comandement. And to the End and Intent that the said Master Wardens and Assistants and their Successors may have and enjoy the full benefit and effect of this our present Grant. Wee doe alsoe by these presents for us our heires and Successors Require charge and Authorize all Mayors Sheriffs Justices of the Peace Bayliffs and other Ministers and Officers of us our heires and Successors to whom it doth or shall appurtaine that they and every of them in their respective Offices and Places bee from time to time favouring aiding and assisting unto the said Master Wardens and Assistants theire Successors and Assignes and every or any of them in and concerning the premisses upon request in that behalfe to them or any of them to be made according as to Justice shall Appertaine. And lastly our Will and Pleasure is And wee doe hereby for us our heires and Successors Grant unto the said Master Wardens and their Successors that these our Letters Patent or the Inrollment thereof shall be good and Effectuall in the law according to the true intent and meaning of the same and shall be taken construed and adjudged in all our Courts of Record and elsewhere most favourably and beneficially for the End and purposes aforesaid.

In Witness etc. Witnesse the King and Queen at Westminster the two and twentyeth day of June.

By Writt of Privy Seale.

It has usually been supposed that the Trinity Corporation were themselves the builders of the first lighthouse at the Eddystone, and that Mr. Winstanley was only the architect. This is a mistake; for after obtaining from the Crown the power to levy dues to pay for the "costs and charges" of a lighthouse, nothing was done for nearly two years. Of the actual date of the commencement, by Mr. Winstanley, of his work, we have I believe no record beyond the fact that it was in the year 1696. Whether the Corporation were all this time looking about for a person to share with them the risks attending the proposed undertaking, it is certain that on the 10th June in that year, an agreement was signed between the Corporation and Mr. Walter Whitfeld, whereby the Trinity House leased to the said Mr. Whitfeld the *whole* of the dues arising by virtue of the Royal Patent, for the term of *five years* from the time of the kindling of a light on the Eddystone, and a moiety of these dues for the subsequent term of fifty years.

Bearing in mind that these dues had been granted to the Corporation for ever; *i.e.*, during the continuance of a light, it seems clear that they were making a very good bargain with Mr. Whitfeld, when they got his assent to erecting and maintaining a lighthouse on so dangerous a reef, in return for such a share of the income to arise from it.

How Mr. Winstanley came to be selected as the director of the building is not actually known; but one authority states that among the number of ships lost on the reef in the latter part of the seventeenth century, were two which were owned by Mr. Winstanley himself.

I have not been able to verify this statement, but give it on the authority of the Rev. W. H. Lyon, Rector of Sherborne, who wrote on the subject prior to 1872, and informs me that he cannot, after this lapse of time, say exactly whence he derived it. If the statement be true, it is not to be wondered at that a man of his mechanical turn of mind, albeit displayed in so eccentric a manner at his house at Littlebury, should join with Mr. Whitfeld in trying to save the property of others from the fate that had befallen his own.[3]

I have said that there is no record of the particular part of the year 1696 when Mr. Winstanley commenced to build, but it must have been in the early summer; for he reckons three summers' work prior to the completion of his first design, and the exhibition of a light in it on November 14th, 1698.

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[3] Miss Jean Ingelow in her poem "The Noble Mercer," in *Good Words*, 1864, adopted this supposition; but her characterizing Winstanley as a mercer, which was Rudyerd's calling, prevents the acceptance of her poem as lending any historic sanction to the statement.

His own account, given on the engraving published just after, is:

> "The lighthouse was begun in 1696, and was more than four years in building, not from the greatness of the work, but from the difficulty and danger of getting backwards and forwards to the place, as nothing could be left there safe for the first two years, but what was most thoroughly affixed to the rock. The first summer was spent in making twelve holes in the rock, and fastening twelve great irons to hold the work that was to be done afterwards. The next summer was spent in making a solid body, or round pillar, twelve feet high, and fourteen in diameter. . . . The third year the aforesaid pillar or work was raised, which to the vane was eighty feet. Being all finished, with the lantern and all the rooms which were in it, we ventured to lodge there soon after midsummer, for the greater dispatch of the work. But the first night the weather came bad and so continued that it was eleven days before any boat could come near us again. . . . [After getting on shore] As soon as the weather permitted we returned again and finished all and put up the light on the 14 Novr. 1698, which being so late in the year, it was three days before Christmas before we had relief to come on shore again, and were almost at the last extremity for want of provisions . . . and so ended this years work. . . . The fourth year finding in the winter (1698–9) the effect the sea had upon the house burying the lantern at times, although more than sixty feet high, early in the spring I encompassed the aforesaid building with a new work four feet in thickness from the foundation making all solid near twenty feet high and taking down the upper part of the first building made it as it now appears."

After the lighthouse was left in its final state by Mr. Winstanley, in 1699, many were the fears expressed for the safety of his curious building; but he was confident of its capability of resisting all the forces of winds and waves. It is well known that the building was utterly destroyed by the terrible storm which visited these islands in November, 1703, lasting many days. This storm was at its height during the night of the 27th, and during its continuance the lighthouse was entirely swept away. The architect himself perished with it, for he had gone out two days before with some workmen to effect repairs.

Immediately after the lighthouse was swept away a vessel was lost on the reef, the property of a Plymouth merchant, Sir J. Rogers. She was laden with tobacco for this port.

I have already mentioned that Mr. Walter Whitfeld was the person who undertook to build a lighthouse on the Eddystone, and that in order to recoup him for his risk and outlay he was to receive a portion of the dues on shipping, granted by the Royal Patent of 1694. Since the building had been erected Mr. Whitfeld's lease had become the property of a gentleman named Lovett, and on him consequently now devolved the duty of re-building the lighthouse, or of forfeiting his right to the dues. Negotiations were consequently opened between him and the Corporation of Trinity House with the view of his being secured an extension of the time during which his lease ran; and it was eventually agreed that, in consideration of the loss he had been subjected to by the destruction of his lighthouse, he and his heirs and assigns should be entitled to receive, from the time when a light should be re-kindled, all the duties which might be granted for the purpose by *Parliament* during the remainder of a term of ninety-nine years, only reserving to the Trinity House a yearly rent of £100. And for the better procuring of such a grant, the Trinity Corporation agreed that its name should be made use of in the petition to Parliament. This agreement was dated January 12th, 1705; and in the following session of Parliament the Act 4 and 5 Anne ch. 20 was passed. It is as follows:

> "4 and 5 Anne ch. 20. An Act for the better enabling the M. W. and Assts of Trinity House to rebuild the Light House on the Edystone Rock.
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> Whereas, in and by one act of parliament made in the eighth year of the reign of our late sovereign lady Queen Elizabeth intituled, &c., they the said M. W., &c., are impowered to erect and set up beacons, marks and signs for the sea needful for avoiding of dangers, and to renew, continue and maintain the same in such manner, as in the said act is mentioned, and whereas, there now is and hath been time out of mind, a very dangerous rock called the Edystone lying off of Plymouth in the County of Devon, upon which divers ships and vessels have been cast away, and the lives and goods of many subjects of this Kingdom lost and destroyed: And whereas, upon application sometime since made to the said M. W. and A. by great number of Masters and owners of shipping, to have a lighthouse erected upon the said rock; offering and agreeing, in consideration of the great charge difficulty and hazard of such an undertaking, to pay to the said Master W. and A. one penny per ton outwards, and the like inwards, for all ships and vessels which shall pass by such lighthouse (coasters excepted who should pay 12 pence only for each voyage) they the

said M. W. and A. having a due regard to the safety and preservation of the shipping, and navigation of this Kingdom, did, in the year of our Lord 1696, cause a lighthouse to be begun to be erected on the said rock, and in three years' time a light was placed therein, and the said lighthouse in the term of 5 years, was with much hazard and difficulty, and at a very great expense, fully built and completed, to the great satisfaction of the flag-officers and commanders of the fleet and ships of war, and of all others concerned in trade, and navigation, the same being not only useful for avoiding that dangerous rock, upon which it was built, but also a guide and direction to ships passing through the channel from and to all parts of the world: *And whereas* the said lighthouse was preserved and kept up for several years, notwithstanding the great force and violence of the wind and sea (to which it was exposed,) until the late dreadful storm in Nov^{r} 1703, when the same was blown down and destroyed: *And whereas* it was found by experience that the said lighthouse, (during the standing thereof) was of public use and benefit, to this Kingdom, &c. And forasmuch as the speedy rebuilding of the said lighthouse is absolutely necessary for avoiding the dangers attending the trade and navigation of this Kingdom, &c., to the end therefore that the said M. W. and A. may be encouraged to new erect and build or cause to be new erected and built the said lighthouse with all convenient speed, and constantly to keep and maintain the same for the benefit, &c.—Be it enacted by the Queen's most excellent Majesty, &c., That from and after the kindling or placing a light useful for shipping in the said lighthouse, so intended to be rebuilt, as aforesaid, there shall be paid to the said M. W. and Assts of T. H. of D. S., their successors and assigns, by the Masters and owners of all English ships, &c., the duty of one penny per ton outward bound and also one penny per ton inward bound, that is to say of the merchant, one moiety and of the owner of the ship, &c., the other moiety; and by all such strange or alien ships and vessels, &c., 2^{d} per ton, &c., and that every coaster passing by the said lighthouse shall pay the duty of two shillings and no more for each time they shall pass by the said lighthouse [to be collected by nominees of T. H., and recoverable by action of debt, &c.].

Whereas by the patent of 1694 English and foreign ships alike paid 1d. per ton, by the new Act the amount to be paid by foreign ships was doubled.

On the passing of this statute, Colonel Lovett lost no time in setting about the reconstruction. He had chosen a Mr. Rudyerd, a silk merchant, of Ludgate Hill, as his architect. It does not appear that Rudyerd had shown any evidences of mechanical genius previously, but the result justified the selection. He was by birth a Cornishman, who, having ran away from home as a boy, had been received into a gentleman's service at Plymouth, and had by him been afforded some amount of education. In his design he discarded all the ornamental accessories which formed so prominent a feature of Winstanley's building, and erected a building with a perfectly plain surface, in the form of a frustrum of a cone.

To assist him in the work two shipwrights from the King's Yard at Woolwich were appointed, and the influence of their training was apparent in the fact that the building was really constructed as a piece of shipwrights' work.

Although courses of moorstone, or granite, were alternated with balks of timber in the lower solid portion of the building, they served only the purpose of ballast. Besides the simplicity of Rudyerd's design, the principal improvement he made was by cutting the sloping surface of the rock into steps to obtain a level foundation. He began the work at the rock in July, 1706; a light was exhibited on July 28th, 1708; and the building was completely finished in October, 1709.

At one period of this work he was met with a difficulty. His men objected to go out, because of the dangers assumed to exist of attacks being made on them by privateers or other more regular means on the part of the French, with whom England was then at war. This no doubt arose out of the incident which was recorded from hearsay by Mr. Smeaton, and, following him, by most of the writers who have had occasion to describe the various buildings erected in succession upon the Eddystone.

Smeaton relates the episode thus:

> "Louis the Fourteenth being at war with England during the proceeding with this building, a French privateer took the men at work upon the Edystone Rock together with their tools, and carried them to France, and the captain was in expectation of a reward for the achievement. While the captives lay in prison, the transaction reached the ears of that monarch: he immediately ordered them to be released, and the captors to be put in their places; declaring, that though he was at war with England, he was not so with mankind. He therefore directed the men to be sent back to their work with presents; observing that the Edystone lighthouse was so situated as to be of equal service to all nations having occasion to navigate the Channel."

All the writers who mention this, so far as I have seen, alike attribute its occurrence to the time when the second structure was being built. As Smeaton does not seem to vouch for the accuracy of the account, I endeavoured to ascertain if any record of the incident was in existence either in the Archives of Paris or in our own Record Office. As regards the former, I was met with every courtesy by the French ambassador in London, who, although he was not in a position to ascertain directly what might exist in Paris on the question, suggested an application to the English ambassador residing in Paris. I am sorry I cannot, however, record my obligation to that official or to any member of his staff, for the simple reason that my letter of application to him was never even acknowledged.

Professor Laughton and other friends ascertained for me that no official notice appears to have been taken of the incident on the part of the English Government. It was no doubt thought too small a matter for such notice at the Admiralty or Home Office; and locally the town records did not usually note matters which did not in themselves concern the town itself or those in power in it.

However, from a contemporary document in the archives of the Trinity Corporation, dated March 11th, 1706–7, it appears that application was made to the Secretary of the Admiralty for the appointment of a man-of-war for their protection. This request was not then acceded to, but a letter was sent to Mr. Rudyerd, stating that "he thinks the workmen need not fear being troubled, since the person that molested those formerly employed was severely punished by the French king, and the men sent back again."

This document, of course, proves that the incident formerly mentioned really did take place, and most likely during the first season's work on Rudyerd's building; viz., in 1706.

After the completion of Rudyerd's building we do not hear of it again until 1716, when the lease was sold by public auction, and purchased by three gentlemen—Messrs. Weston, Cheetham, and Noyes. The purchase money was subscribed by these persons in the proportions of three-eighths by each of the two former, and two-eighths by the third.

In 1729 an incident is mentioned in the diary of Mr. Pentecost Barker, of Plymouth, a purser of the navy, and acting as agent for the Trinity House, in connection with the lighthouse, which shows that the lightkeepers had other difficulties to contend with in maintaining the continuance of their beacon light than those which arose from the violence of the storms, which, as we know, often prevented access to the building from the shore for weeks together. In this case the light itself was in danger of extinction, and perhaps did actually fail to be exhibited, because of Mr. Barker's avowed neglect.

The entry in Barker's diary seems somewhat ludicrous; but if the statement is to be taken as literal, much danger must have arisen, and perhaps some loss, from his dereliction of duty.

Under date December 8th, 1729, he writes:

> "This was a day of great trouble and perplexity, because I was under great Concern about the people at Edystone, who have no Candles, and as this is in some measure under my Care, I so teiz'd and fretted myself about it, that I had near brought on my Fits."

A more serious difficulty arose from the arrangements made during the earlier period of the existence of the lighthouse. There were then only two keepers employed, and as regards the actual duty of attending to the light, that number was amply sufficient. But on one occasion, of the date of which there is no record, one of the two men was taken ill, and died. The position of the survivor then became most painful. The signal flag was hoisted, but on account of the roughness of the weather no vessel could come off. In time the body became offensive, and the survivor thought of throwing it into the sea; but reflecting that if he did so, he had no witness to show that he had not himself been the cause of his comrade's death, he desisted. It was nearly a month before the attending boat could effect a landing, and the agony suffered by the one living man, so long confined in so narrow a space with death in so palpable and offensive a form, can scarcely be imagined. Ever since then there have always been three keepers on duty at a time at the Eddystone.[4]

Horrible as this incident was, it has been made the subject of fiction. A writer in *Frazer's Magazine* for 1849, has embodied it in a narrative purporting to be extracted from the diary of the survivor, in which he is made the cause, through fear of having to pass the dead man in the lantern, of neglecting to kindle the *lamp* during *one* night, and of thus being the occasion of the wreck upon the reef itself of a large vessel, and the loss of all her crew. The narrative is a very thrilling one, but full of anachronisms.

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[4] In *Nature*, vol. xl. p. 88, Sir J. N. Douglass is reported as having stated that a similar case occurred in 1802 at the Smalls, but on what authority is not mentioned.

So well did Rudyerd's lighthouse answer the purpose for which it was built, that the storms of forty-five winters passed over it; and it was not till the morning of December 2nd, 1755, that those on the look-out from Plymouth and Cawsand, discovered that it had been attacked by an enemy totally unforeseen. A thick cloud hanging over the top of the lighthouse led the observers to conclude that it was on fire. This was only too true.

On going into the lantern about two o'clock on that morning, Henry Hall, one of the keepers, found it full of smoke. This proceeded from the roof, and Hall immediately fetched buckets of water, and endeavoured to extinguish the flames with them.

The height to which the water had to be thrown, and the distance to be traversed by the other two men in fetching it from below, made their efforts in this direction of little avail. They had to retire before the flames from room to room, and at last were obliged to take refuge in the natural cavern at the base of the rock—fortunately it was low tide at the time. From this situation they were rescued by some fishermen from Cawsand. Admiral West, who was then in the Sound with his fleet, sent out a launch with an engine, but their efforts did not avail to prevent the total destruction of the building.

On reaching land, the principal lighthouse-keeper, a man over ninety years of age, was found to be so exhausted with the strain he had undergone, that medical treatment had to be afforded him. He told a curious tale; how that while throwing up the water in the hope of extinguishing the fire in the cupola of the lantern, a shower of molten lead had fallen over his head and shoulders, and he persisted in the belief that some of it had even entered his mouth, and passed down his throat. Although Mr. Spry, the surgeon who attended Hall, used every means to alleviate the old man's pain, and to cure the burns that were apparent, he could not believe that Hall had really swallowed any of the molten metal. However, after lingering twelve days Hall died, and a post-mortem examination revealed the fact that his idea had been correct. A mass of lead, of a flat oval form, seven ounces in weight, was removed from the stomach.

This occurrence was reported in the papers of the time, and for a while the statement was looked upon as a fiction. Even the Royal Society shared that opinion, to the extent at least of deferring the acceptance of Mr. Spry's account of the case, which he sent them on the 19th December. In order to show the possibility, Mr. Spry made some experiments on fowls, dogs, &c., showing that these ate and drank, and survived for many days, after doses of melted lead had been administered to them. The result of these experiments being certified by Dr. Huxham, as well as the experimenter, the Royal Society admitted Mr. Spry's description of the case, and a full account may be found at page 477 in vol. xlix. of the *Philosophical Transactions*.

The lease of the light dues, which had been held in shares by the three persons previously mentioned, had, on account of deaths and marriages in these families, been greatly sub-divided; but it so happened that Mr. Robert Weston's share was such that the rest of the proprietors deputed him to act for the whole body. As soon therefore as the lessees heard of the destruction of their building, he immediately applied, on their behalf, to the President of the Royal Society, and asked him to recommend some one to act as architect of a new edifice. Lord Macclesfield at once thought of Mr. John Smeaton, who had, two years before, been elected a Fellow of the Royal Society.

He had been brought up to the trade of an instrument-maker; but having turned his attention to various mechanical inventions, had given up his shop, and entered upon some engagements as a civil engineer.

At the time the lighthouse was burnt he was at work in Northumberland, and hesitated about undertaking what he thought was merely the task of repairing the former building. When, however, he understood that the lighthouse had been totally destroyed, and that the work was one worthy of him, he quickly completed the engagement in hand, and came to Plymouth.

When he had inspected the rock, and made himself acquainted with the style of the previous building, he at once suggested to the lessees that the new structure should be of *stone*.

At first this idea staggered them, not only because of its extra expense, but because it was generally believed that no stone building could be made to cohere in such a manner as to withstand the force of the sea. He quickly convinced them of the superiority of his proposals, and he was given almost *carte-blanche* in regard to their execution.

While actively preparing for a permanent building, the lessees did not lose sight of the dangers to navigation arising from the want of a light at the reef. They therefore proposed to the Trinity Board that a lightship should be prepared, and moored in a proper position near the reef. Various disputes arose about the vessel, and the place of her moorings, &c.; and the Corporation, having obtained from the king a Patent for a Floating Light eventually refused to allow the lessees to exhibit one themselves, and sent down a vessel for the purpose. This was moored two or three miles off the rock; and when it was not, as often happened, driven from its moorings, and compelled to lay up in Plymouth Harbour, its badly-chosen position was the means of luring vessels into danger. Smeaton mentions several serious disasters that happened while he was building, because vessels thought the light was close to the reef, and consequently, by keeping away from it, went upon the rocks themselves. Many lives would have been lost if Smeaton's men had not been at hand in their vessel, the *Neptune*, to render assistance to the wrecked mariners.

Many obstacles were thrown in Smeaton's way, besides the natural difficulties which he had to encounter. It would hardly be credited, but such was the fact, that Mr. Smeaton, being in search of a place of which the floor was sufficiently large for him to fit all the moulds together, in the order in which they were to be permanently fixed, applied to the mayor for the use of the Guildhall. This was refused, on the ground that the chalk-marks would spoil the floor; and the proprietor of the Assembly Rooms of the time declined to allow them to be used, for some similar reason.

Notwithstanding the difficulties, natural and otherwise, which Smeaton had to contend with, he completed his tower on October 9th, 1759, and a light was exhibited in it for the first time, pursuant to public advertisement, on the 16th. The first stone had been laid on the 12th June, 1757.

Of the character of Smeaton's building I need say nothing, seeing that anyone interested can examine it for themselves in its present situation on our Hoe. It will suffice to say, that although exception has been taken to his reasons for adopting the particular form he did—and I believe, scientifically speaking, these reasons were shown by Mr. Alan Stevenson to be fallacious—yet his fabric has been the model on which subsequent lighthouses have almost without exception been constructed.

It is said that he was wrong in taking the oak as his model (the Cowthorpe oak being the particular one which inspired him with the idea), because the action of the winds upon the outspread branches of the tree is different from that of the waves upon a pillar rising from their midst.

Some improvements in this respect have consequently been introduced into recent erections, and notably the Douglass tower. But it was from no defect of form or construction that it became necessary to remove Smeaton's lighthouse.

Very curiously, it has been stated, over and over again, that Smeaton's lighthouse, either in whole or in part, was destroyed (and by fire too) in 1770, and rebuilt in 1774. Other writers vary this fiction by stating that Smeaton *built* his lighthouse in 1774. I first met with this latter assertion in the volume of Cooke's *Topographical Library* containing an account of Devonshire. (p. 215.) There are various editions of this work, most of which repeat the same error, but the one I quote from was published between 1820 and 1824. A view of the building, published about 1839 by Cleave's *Penny Gazette*, has the legend, "Erected 1774." I should have taken little notice of this curious error, but that it seems to have been accepted as true by persons who would have been expected to have known its impossibility.

For instance, so eminent a member of the Royal Archæological Institute as Mr. Octavius S. Morgan, in the introductory remarks to his article, published in the Society's *Journal* in 1878, describing a silver model of Winstanley's lighthouse as he first built it, makes this express statement. Speaking of the third lighthouse, he says, "One built by Mr. Smeaton partly of timber in 1759. Of this the woodwork was burnt in 1770, but renewed by him with stone and metal in 1774, since which time it has remained uninjured."

Considering that so eminent an antiquary would not have made this assertion without at least supposing that he had some foundation for it, I endeavoured to communicate with him, in order to ascertain on what grounds he based the words. I found, however, from the courteous reply of the secretary of the Archæological Institute, that Mr. Morgan died a year or two ago.

What could have led to the perpetration of the mistake I cannot understand, unless some other lighthouse was burnt at the time named, but I have not been able to ascertain whether such was the case or not. It occurs in such works as *Haydn's Universal Index of Biography*, edition 1870, where, under the name of Smeaton, we are told that he "rebuilt Eddystone Lighthouse in 1759. The woodwork burnt and replaced by stone 1770." *Haydn's Dictionary of Dates*, published in 1866, says the same in speaking of the lighthouse itself; while the edition (I believe the original) of 1841 says of Smeaton's building, "Of this last, the woodwork was burnt in 1770, but it was afterwards renewed with stone, and has continued uninjured since 1774."

Even the generally accurate *Penny Cyclopædia* (1837) tells us that "the upper part of the building, constructed of wood, was burnt in 1770, and renewed in 1774."

Barclay's New Universal Dictionary, published in 1835, only states that the present lighthouse was completed by Mr. Smeaton in 1774.

Rees's Cyclopædia, 1819, and *Brooke's Gazetteer*, 1814, repeat the fuller notice; and the earliest instance in which I have found it is in *Oulton's Traveller's Guide*, issued in 1805.

Only one of our local guide-books assists in propagating this fiction. This was the *View of Plymouth Dock*, 1812, for a sight of which I am indebted to the kindness of Mr. Brooking Rowe. This guide says, "It was erected by the ingenious Smeaton in the year 1774, and is the third lighthouse," &c.

What has struck me as very curious is that *Brindley's Plymouth, Devonport, and Stonehouse Directory*, published at Devonport in 1830, gives a very short but accurate account of the Eddystone and the building of the three lighthouses; and in the list of chronological events, each of the two former is mentioned under the dates of its commencement, completion, and destruction; and Smeaton's is mentioned as having been begun on June 1st, 1757, and finished in 1759. Curiously, however, against the meagre entry by Brindley of 1770 that "Joseph Tolcher was Mayor," a former owner of the copy now in our own library has written, "The Light House burnt;" and this sentence has, in ink of almost if not quite the same colour, been cancelled with a line drawn through it.

To any one who has seen and examined Smeaton's building the whole tale will appear, not only a fiction, but an impossibility. In fact, the history of Smeaton's lighthouse is quite devoid of any incidents such as are related of the former ones.

The only note I have is that in 1762 Dr. Johnson was in Plymouth, and on that occasion "the Commissioner of the Dockyard paid him the compliment of ordering the *yatcht* to convey him and his friends to the Eddy-stone, to which they accordingly sailed. But the weather was so tempestuous that they could not land."

As I have said, it was no defect in the lighthouse itself which led the Trinity Board to substitute the existing magnificent structure, but the discovery that (as indeed Smeaton had foreseen) by the action of the waves upon the rock itself, and especially through the existence of a hollow underneath the foundation, the lighthouse was in danger of being some day bodily overset. The events connected with the erection of the present building, and the eventual removal of all those portions of Smeaton's that could be taken to pieces to be erected over a new base upon the Hoe, are too fresh in our memories to need any remark from me.

This removal, however, roused public attention and interest, which was followed up in the pages of our local *Notes and Queries*, the *Western Antiquary*, by various enquiries and suggestions respecting the etymology and signification of the name.

The name Eddystone in its present form seems so simple as to carry its derivation and meaning upon its face; but it was pointed out that no longer ago than 1842 it was spelled (locally) Edystone.

This was the form used by Smeaton throughout his great work, *The Narrative of the Building of the Edystone Lighthouse*, published first in 1791, and re-issued in 1793 and 1813. It is also so spelled in the Act of Anne before mentioned. Further investigation showed that it had also been spelled Eddi-, Edye-, Edie-, Edi-, Ede-, Ide-, and Idy-stone.

These variations led some to conclude that the prefix did not bear the simple meaning we now attach to the word, but that it was a corruption from some Anglo-Saxon "personal name." The principal advocate of this view, besides bringing forward some of the variations of form I have mentioned, as arguments that the name was so derived, also showed that certain place-names, with which the family names of Edye, or Eddy, were connected, had undergone somewhat analogous changes.

The great difficulty in settling definitely the origin of the name is, that our earliest instance of it is of the date of 1478 only.

Captain, now Major Edye, pointed out that philological experts, like Professor W. W. Skeat, were of opinion that the Edi, or Ede, of the early forms of Eddystone, might very possibly be derived from one of several Anglo-Saxon personal names, or from the word Eadig = happy, fortunate = *saint*, which is constantly found spelled *Edi* in the 13th century.

The authorities cited by Major Edye, with those whom I have myself consulted, are quite conclusive as to the etymological *possibility* of the derivation of the prefix Eddy in this way. But these authorities equally agree that it may just as well have been derived in the way I shall endeavour to show later on.

To my mind the objections to the view that the prefix is a corruption from some personal name are too serious to admit of that solution of the question. Places with designations derived from *personal* names obtain these appellations through some connection between the person and the place, either of *possession*, or of *residence;* or on account of the *occurrence* at the place of some special *event* in his history. Now at the Eddystone only the last of these reasons is applicable, for no one could have ever lived upon it, or had it for a possession.

We can only suppose, then, that some prominent Anglo-Saxon chief *might* have met his death on the Eddystone, or been wrecked upon it, and fortunately escaped death.

But is it likely that if such a thing happened all trace of the event or of the particular person would have perished? For his name to have been given to the rock he must have been some one of great importance; and if so, it is not likely that the *individual* and the *event* which is supposed to have caused the original name to be given to the Eddystone would have been lost sight of altogether.

The fact of the Casquets, off Alderney, being the place where the son of Henry I. was lost, is kept in memory, though the name has no connection with the event. The very circumstances of the Eddystone would render utterly improbable the idea that its name could have been derived from the Anglo-Saxon word

Eadig = *saint*, or *happy*, or *fortunate*. Ideas like these are the last that would have been connected with such a place in those early times.

Moreover, I believe there does not exist on the British coasts any instance of a rock or uninhabitable island similarly situated—that is to say, standing isolated and far away from land—the name of which can be, with any certainty, derived, by corruption or otherwise, from a personal name. We have, indeed, the Bishop and his Clerks, and Queen Elizabeth's Rock; but these, besides the difference of their situation to that of the Eddystone, are named from fancied resemblances in their shapes.

If any member can point to a single instance of such a rock as the Eddystone being named after some *person*, he will confer a favour by mentioning it, for I have failed to find any. And I have made diligent search for such a case, both on my own part, and by enquiry in the columns of *Notes and Queries*, and also direct of such philologists as Professor Skeat, Dr. J. A. H. Murray, Sir J. A. Picton, and the Rev. Isaac Taylor, for whose assistance in this matter I must here return my hearty thanks.

My contention then is, that in spite of the varying forms under which the name has appeared, it was in its earliest, as well as its latest, simply the Eddy-stone, or Rock of the *Eddies*.

But in order to show this I must now deal with the word Eddy = a swirl or whirling of the waters. It used to be thought that this word was derived from two words, Ed = back and ea = water, but this idea is now exploded, and Professor Skeat, in his Etymological Dictionery (second edition, 1884), considers it to come "[either from a lost A. S. word with the prefix ed = back, or more likely modified from the Scandinavian by changing Icel. ið to the corresponding A. S. ed.] Icel. iða, an eddy, a whirlpool; cf. = iða, to be restless, whirl about = Swedish dial. iða, idå, an eddy; Dan. dial. ide, the same (*Rietz*)," &c.

In the *Book of the Houlate*, by Sir John Holland, about 1453, it is written ydy.

Then I find the word as Edd*ie* in *Purchas, his Pilgrims.*[5] Describing the whale, he says, (His foode) "is grasse and weeds of the Sea, and a kinde of water-worme like a Beetle, whereof the Finnes in his mouth hang full, and sometimes little birds; all which striking the water with his Tayle, and making an *Eddie*, he

[5] London, 1617, fo., 8th Booke, ch. iii, p. 923, l. 39, &c.

gapes and receiueth into his mouth, neither is anything else . . . found in their bellies."

And again,[6] "The master was confident in this and other places that the flood came from the West, which Baffin sayth by the floting of the ice hee observed on Land to be contrary: only the Islands cause by their diuers points, differing Sects (*sic*) and *Eddie.* Line 26 has plural *Eddies.*"

By the kindness of Dr. Murray, the principal editor of the *Philological Society's New Dictionary*, I am now able to quote, from the material sent to him, some forms of the word eddy, both simple and in combination, which will I think support the inference I wish to draw from the various forms of the name Eddystone.

In 1627, Smith's *Seamen's Grammar*, ch. x. 46, speaks of a *eddie*-wind, and on 48 of an *eddie*-tide; while in 1626, W. Sandys, in his *Translation of Ovid's Metamorphoses*, book v. p. 104, says:

> "When wellnigh tyrd; a silent streame I found,
> All *eddi*less, perspicuous to the ground
> Through which, you euery pebble might have seen,
> And ran, as if it had no Riuer been."

This form is exactly analogous to the Eddistone before quoted.

Again, in 1627, Drayton, in his *Agincourt and other Poems*, p. 42, thus speaks:

> "Looke how you see a field of standing corne
> When some strong winde in Summer haps to blowe,
> At the full height, and ready to be shorne,
> Rising in waves, how it doth come and goe,
> Forward and backward, so the crowds are borne,
> Or as the *Edie* turneth in the flowe;
> And above all, the Bills and Axes play
> As do the Attom's in the sunny ray."

Between *this* last quoted form and the old Norse iða, nothing has apparently hitherto been found; but I venture to suggest that both the forms which iða would naturally develop into, are found in the prefix Ede, in the name Edestone as used by William of Worcester, and in that of *Ide* in the *Ide*stone of the documents and maps, &c., of 1584, 1586, and 1590.

In corroboration of my idea, I may mention that Dr. Murray wrote to me (*prior* to my informing him of the existence of the forms *Ide*stone and *Ede*stone) as follows:

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[6] Booke 8, ch. iii. § vii. line 12, &c.

"There may have been an O. E. cognate to iða, with form ide or ede not found in O. E., but the direct ancestor of *Edie*, *eddie*, eddy."

It is curious that while the modern form of spelling was introduced as long ago as 1664, what may be considered the purer form on etymological grounds—that with one *d*, I mean—remained largely in use until the present century, and was even used locally as late as 1842. It must be borne in mind that mere variations of spelling are of little account. Moreover, the change from the form with one *d* to that with two is found in the word "Eddy" itself, and is according to philological precedent. The significance of this change has also been much exaggerated. A writer in *Notes and Queries* (September 4th, 1886, page 191) says, "*Tch*, *dg*, *ck*, *or kh*, *gh*, *nn*, *dd*, *ll*, and all the doubled consonants, are no more than sound symbols and expedients to represent not two sounds, but one—that of the *short* consonant sound, of which *ch*, *j*, *k*, *g*, and the single consonants, are the complements."

From acquaintance with one who wrote the name as "Edystone," I can vouch for the fact that even when so spelled it was pronounced "Ed-y-stone," just as now. Besides this, by the laws of philological change, involved in the alteration from *iða* to *idy*, *ide* and *ede*, we are led to conclude that these forms—Idyston, Idiston, and Edestone—were respectively pronounced "Id-y-ston," "Id-i-ston," and "Ed-e-stone." Consequently there is very little presumption in assuming that this was the character of the pronunciation all through. We find in several cases two or more forms of the name used in one book, and that not only in later, but in earlier times. In one part of Brice's *Gazetteer* (1750) the form with one *d* is used, and in another that with two *d's*. So in the *Expeditionis* three forms are given in different charts. Surely this shows that the writers supposed that each spelling—Edestone, Ediestone, and Edystone—meant the same thing, and that that was the *eddy* which rendered the rock so dangerous.

It is not a fresh idea that the rock is named from the *eddies* which are associated with it. On the contrary, I cannot find that any other explanation was even suggested, until a writer in the *Western Antiquary* started the proposition that it might have been derived from a *personal name*, and this proposition was afterwards elaborated by Major Edye.

Instead of this, Defoe, in 1724, speaks of these rocks as being named "from their situation."

A century and a quarter ago, although spelling the name of the rocks "Edystone," Smeaton says, "They are supposed to have got this appellation from the great variety of contrary sets of the tide or currents amongst and in the vicinity thereof." And after explaining the reasons for the great irregularity of these currents, he proceeds, "Therefore they may very properly be termed, as they are, the Edystone Rocks."

Polwhele, Oulton, and others, following on Smeaton, give the same derivation; and Robert Mudie, Gaelic professor at Inverness, in his *Companion to Gilbert's New Map of England and Wales*, in 1839, thus writes (p. 52): "The once dreaded and dreadful rock of the Eddystone, which literally means '*the stone of the reeling waves*,' a truly descriptive appellation, lies . . . near the point where the strongest eddy of the bay holds conflict with the tide round the Lizard."

These were not men who were likely to be led away with superficial views of philology, or false ideas of analogy, based on mere phonetic similarity. If there were *no* eddies at the reef, and yet from the fact of the prefix Ede, Edi, or Edy, having a similar sound to the ordinary word *eddy*, the derivation had thereupon been assumed from the supposed physical characteristics of the spot, there would be room to doubt the correctness of the assumption. But in this case every thing fits. The eddies are there, there is no doubt about that, and the earliest forms of the prefix are Ide and Ede, both of which it is admitted would be likely changes from the Norse iða = an eddy.

And while these and succeeding forms continued to be spelled in a manner etymologically correct, the *d* into which the hard Anglo-Saxon *th* had been changed remained single.

But the use concurrently of the forms with two *d's* clearly shows, by evidence over two hundred years old, that the then *new* spelling of the word "eddy" was held to signify, in combination as Eddy-stone, that Ede, Edi, and Edy, were only earlier spellings of the same word, indicating a "whirl of waters."

VARIOUS FORMS OF EDDY-STONE (CLASSIFIED).

(A.S. *iða* = 'eddy.')

YDY-*stone.*—1453.

EDE-*stone.*—1478, William of Worcester; 1590, Ryther's *Discourse;* 1759, Tablet at St. George's Church, Stonehouse.

IDE-*stone.*—1586, Camden's *Britannia*, first edition; 1587, Camden's *Britannia;* 1590, Camden's *Britannia*, also *Mariner's Mirrour;* 1594, Camden's *Britannia;* 1607, Camden's *Britannia;* 1640, *Canalis inter Angl. et Galliæ;* 1646, *Arcano del Mare;* 1676, *De Nieuve Water Wevelt*, Amsterdam; 1695, Camden's *Britannia;* 1722, Camden's *Britannia;* 1789, Gough's *Camden.*

IDY-*stone.*—1599, Hakluyt's *Voyages.*

EDI-*stone.*—1604, Barker's *Of Headlands;* 1623, Letter of Sir William Monson; 1646, *Arcano del Mare;* 1660, Burston's *Portolano;* 1670, Comberford's *Portolano;* 1707, *Beaux Stratagem*, act v. sc. 4; 1720, Burchett's *Complete Naval History;* 1750, *Universal Mag.*, and Pocock's *Travels;* 1755, Wyatt's *Adventures;* 1764, Atlas Maritime; 1768, Ellis's *Map;* 1774, Postlethwayt's *Dictionary of Commerce;* 1778, Brooke's *Gazetteer;* 1791, *Beaux Stratagem.*

EDDI-*stone.*—1623, Letter of Sir William Monson; 1710, Willdey's *Devon;* 1720, Burchett's *Naval History;* 1724, Moll's Map; 1731, Moll's Map; 1736, Moll's Map; 1742, Badeslade and Toms; 1748, *Universal Magazine;* 1757, Martin's *Magazine;* 1759–90, Various Maps; 1799, Lipscomb's *Journey into Cornwall.*

EDIE-*stone.*—1584, Norman's *Safeguard for Sailors;* 1590, Ubaldino's *Expeditionis.*

EDY-*stone.*—1590, Ubaldino's *Expeditionis;* 1699, Winstanley's Print; 1704, Defoe's *Storm;* 1705, Act of Queen Anne; 1706, Petition from Winstanley's Widow; 1709, Act of Queen Anne; 1713, Bickham's *British Monarchy;* 1722, Camden's *Britannia;* 1724, Moll's Map; 1729, *Diary of Pentecost Barker;* 1733, Sailmaker's Print of Edystone Lighthouse; 1745, *Description* *of England and Wales;* 1748, Bickham's *British Monarchy;* 1755, Beaumont and Disney's *Tour;* 1756, Reasons for Rebuilding Lighthouse, *British Museum;* 1759, Brice's *Gazetteer;* 1762, Letter, Dr. Mudge; 1791, Smeaton's *Narrative;* 1793–94, Various Maps; 1798, Gilpin's *Observations on West of England.*

EDYE-*stone.*—1636, Letter from the Mayor of Plymouth.

EDDY-*stone.*—1664, Trinity House, Report on Petition; 1693, Collins's *Coasting Pilot;* 1694, Patent for the first Lighthouse; 1701–2, Bateson's Petition; 1704, Defoe's *Storm;* 1706, Letter, Trinity House; 1707, Letter, Trinity House; 1708–9, Hovenden Walker's Diary, and Letter, Trinity House; 1716, Gay's *Trivia;* 1720, Gay's *Trivia;* 1724, Defoe's *Tour;* 1730–31, Gay's Poems; 1737, Gay's Poems; 1739, Morant's *Defeat of Spanish Armada;* 1745, Gay's Poems; 1755, *London Magazine* and *Gentleman's Magazine;* 1756, Patent for Floating Light; 1757, *Gentleman's Magazine;* 1758, Borlase's *Natural History of Cornwall;* 1759, Brice's *Gazetteer;* 1762, Defoe's *Tour;* 1764, Mortimer's *History of England;* 1769, Borlase's *Antiquities of Cornwall;* 1770, Gay's Poems; 1774, British Museum, Copy of Letter by Lieut. McKenzie; 1776, 7, 8, 9, Gay's Poems; 1781, *Great Britain's Coasting Pilot;* 1788, *England Delineated;* 1797, *Encyclopædia Britannica.*

EDYN-*ston.*—1625, Sir John Glanville, *Voyage to Cadiz* (Camden Society).

OUR VERNACULAR: LOGICAL, GRAMMATICAL, AND GROTESQUE.

SYLLABUS OF LECTURE BY T. WINTER-WOOD.

(Read 21st February, 1889.)

THIS paper was a *resumé*, as far as the time-limit would allow, of the various errors of grammar and logic which, either from ignorance, carelessness, or indifference, so constantly disfigure our every-day conversation. The controversy which recently took place between the *Western Morning News* and the *Saturday Review*, with respect to the error made by the latter in using "lay" instead of "lie," was severely criticised, and a point claimed for Western journalism—the lecturer expressing his surprise that it had been necessary to notice such a time-worn vulgarism at all in the present state of cultured English. On the other hand, the boastful tone of some recent *dilletante* critics, in describing the English language as the "richest and finest in the world," was pointed out by comparisons with the French, and illustrated by phrases which were difficult to express clearly and grammatically in English, even with the powerful aid of Lindley Murray at our elbow. The most conspicuous of these exposed the weakness of our possessive pronouns. The letter H—that *bête noire* of so many of our suffering fellow-creatures—was discussed, and the *faux pas* connected with it was suggested to have its cause in a defect of the ear akin to that of colour-blindness to the eye—examples of various experiences, from investigators of the subject, being adduced. The question of a universal language was alluded to, with its aspirations and prospects. The recent introduction of Volapük for commercial purposes was condemned as inappropriate, springing as it does from the harsh German, a wrong key-note. The grotesque side in the abuse of our vernacular was throughout made prominent by examples and anecdotes of a humorous character, which caused much amusement.

NOTES ON THE NORTH-WEST TERRITORIES OF CANADA.

RESUMÉ OF LECTURE BY RICHARD A. PENROSE.

(Read 28th February, 1889.)

THE British North American dominions are considerably larger than Europe. The country north of the St. Lawrence, and up to the "Rockies," may be divided into two districts. The eastern part, to the line of lakes running north from Winnipeg, is almost entirely occupied by the Archæan rocks, and covered with fir forests. West of that line the later rocks occupy the whole region, generally having over them a huge deposit of silt and glacial detritus, with a grassy covering. This is the Canadian North-West. It is, comparatively speaking, still almost unpopulated, as in many places you can travel for over a hundred miles without meeting any one. The rivers drain north and north-east —the wrong way for commerce—and they are not likely to considerably help the country's development; but, fortunately, railways can be easily and cheaply made. Granted business-like financial management—an absence of hurtful speculative booms, either in land, in trading, or in railway construction—and there is every prospect of steadily-improving prosperity. Future emigrants will reap the benefit of the experience now being gained by present settlers; and there will gradually accumulate a numerous population, hard-working (for it is only by hard work that success can be obtained) and hardy, as the climate is essentially conducive to healthy, strong frames—a population forming the best sort of nucleus for a nation able to take care of itself, and be a credit to the English-speaking race. Much time is lost by town-bred youths going out without experience or adequate ideas of the peculiarities of the life before them. It cannot be too strongly insisted on, that previously to leaving England they should experience a short apprenticeship of hard farm-work and horse and cattle-tending; and they will find invaluable any knowledge secured of rough carpentering and the handling of tools generally. Waggon-travelling on the prairie is so essentially different from any journeying at home, that there is a great charm in it, although it is lonely, and comforts are conspicuous by their absence.

THE POEM OF THE CID.

SYLLABUS OF LECTURE BY REV. J. ERSKINE RISK, M.A.

(Read 7th March, 1889.)

THE poem itself necessarily the chief object of enquiry. I. The historical personality has been disputed (by an alleged descendant!), but without reason. Some at least of the recorded events manifestly historical. Fragmentary opening of the poem, and quotation. II. Particulars respecting the poem and its literary character; place where written, and manner of recitation. Query as to author. Contents, plan, and historical (*i.e.* non-mythical) character. Poem composed of two cantos, which Spaniards call "cantarés," each cantaré terminating with a marriage—first, of Cid's daughters with the Counts of Carrion; second, of the same ladies with the Princes of Arragon and Navarre. Truth and naturalness of the poem. Illustrated by account of sally, from the beleaguered Castle of Alcoçer, against the Moors. Episodes in the poem. "The Forest of Carpés" and "The Cortes of Toledo." Incident in the combat with the Counts of Carrion, and their final overthrow. III. The poem as an historical monument. Similarity of early Spanish and French manners, customs, and superstitions. Bearing of this on the question of the formation of the Spanish tongue. Instances of French influence on the language of the poem, as well as on the versification. Style of the versification not Arabic, but distinctly modelled on the old French types. Proof from the old Provençal and French romances and chansons.

THE SHÛ KING;

OR, THE OLDEST OF THE SACRED BOOKS OF CHINA.

SYLLABUS OF LECTURE BY REV. S. VINCENT.

(Read 14th March, 1889.)

A COLLECTION of Chinese historical documents, said to extend from the twenty-fourth to the seventh century B.C. Its place amongst the Chinese classics. Its compilation and probable sources. The legendary character of its earlier portions, with some clear indications of true history. A date fixed by the mention of culminating stars. The triad of great emperors, Yâo and Shun and Yü. Their ministers, maxims of government, &c. Early mention of war and drunkenness. Degenerate kings; *e.g.* Thâi Kiâ. His punishment and reformation. Yüeh the Builder and his sayings. The hounds of Lü. The Duke of Kân and the metal-bound coffer; a story of singular devotion. Against luxurious ease. And a general view of the teaching of the whole book upon: 1. Human nature. 2. Religion—(*a*) divination; (*b*) fate; (*c*) ancestral worship. 3. Statecraft—(*a*) the people, their worth, need, and claims; (*b*) rulers, their duties, and their rights as depending upon the performance of their duties. Some wise sayings quoted. General estimate of the book.

ON THE TRACK OF THE "OLD MEN," DARTMOOR.

PART II.

BY ROBERT BURNARD.

(Read 21st March, 1889.)

THE earliest miners on Dartmoor were the tin streamers. Streamstones of tin, consisting of rounded nodules of very pure tin oxide, must from their weight have attracted the attention of man when emerging from the Stone Age into that of the Bronze. As knowledge grew, and the demand for tin increased, he dug down deeper into the earth, forming open shallow pits, or traced the tin in deep open trenches. Later on he commenced to tunnel and sink shafts, and as his skill in devising means for unwatering and ventilating the mine developed, these became longer and deeper.

The earliest smelting furnaces were simple in their construction, but, owing to the purity of the ore, tolerably effective. A few fairly-shaped stones to form the hearth, luted with clay, and a blast from inflated skins or bellows of rude construction, excited sufficient heat in the peat or wood charcoal to reduce the ore to a metallic condition. These small and simple furnaces, put together with no condition of permanency, easily disappeared and made way for a more perfect and durable arrangement.

Pryce states in his *Mineralogia Cornubiensis* that some late discoveries, where the charcoal and metallic dross had been found mixed together, had given him an idea of the early smelting process, which was to dig a hole in the ground, and throw the tin ore on a charcoal fire, which probably was excited by a bellows. It is, however, probable that a race of men who were capable of erecting maenhirs, cromlechs, and kistvaens, would not long be content with such a crude and wasteful arrangement. Dartmoor has thus far yielded no recorded instance of the discovery of such actual furnace remains of very great antiquity. It would be unsafe to assume that such do not exist, and they may yet be found in or near the hut circles, which occur in such numbers, and in such proximity to ancient stream works.

The production of tin in such a manner and in such small quantities must have made this metal valuable and comparatively scarce. To a certain extent it was employed in early coinage, especially in Gaul, there being only two or three recorded discoveries of such coins in this country. In this shape the metal does not appear to have been current in Devon and Cornwall. The specimens found have nearly all come from Kent, though one has occurred as far west as Dorsetshire. Mr. Evans in his *Ancient British Coins* describes nine, the whole of which have been cast and not struck; and for this purpose it would seem that wooden moulds were frequently used, as the impression of the grain of the wood may be seen upon some of them.

There is a great blank in our knowledge of the progress made in mining matters, and it is only when we come down to mediæval times, and even to a later period than this, that we are able to follow it with any degree of confidence. The Germans were great adepts in the working and management of mines, and there are indications that they were probably employed for the purpose of improving English methods some centuries since. Queen Elizabeth, we know, imported skilled miners from Germany, with the most beneficial results, and it is certain that from this period a great development and improvement in English mining took place.

The Almain or German furnace superseded the older type, whatever that might have been, and remained in actual use down to about a hundred years ago. Pryce writing shortly before 1778 thus describes them:

> "The furnace itself for blowing the tin is called the castle, on account of its strength, being of massive stones cramped together with iron to endure the united force of fire and air. This fire is made with charcoal excited by two large bellows, which are worked by a waterwheel, the same as at the iron forges. They are about eight feet long, and two and a half wide at the broadest part. The fireplace, or castle, is about six feet perpendicular, two feet wide in the top each way, and about fourteen inches in the bottom, all made of moorstone and clay, well cemented and cramped together. The pipe or nose of each bellows is fixed ten inches high from the bottom of the castle, in a large piece of

wrought iron called the hearth eye. The tin and charcoal are laid in the castle, *stratum super stratum*, in such quantities as are thought proper; so that from eight to twelve hundredweight of tin, by the consumption of eighteen to twenty-four sixty gallon packs of charcoal, may be smelted in a tide of twelve hours' time. Those bellows are not only useful for igniting the charcoal, but they throw in a steady and powerful air into the castle; which, at the same time that it smelts the tin, forces it out also through a hole in the bottom of the castle, about four inches high, and one inch and a half wide, into a moorstone trough, six feet and a half long [in the original it says six and a half feet high, but this is obviously a misprint] and one foot wide, called the float, whence it is laded into lesser troughs or moulds, each of which contains about three hundred of metal, called slabs, blocks, or pieces of tin, in which size and form it is sold in every market in Europe; and on account of its superior quality is known by the name of Grain tin, which brought a price formerly of seven shillings, that is further advanced, the last two or three years, to ten or twelve shillings per hundred more than mine tin is sold for, because it is smelted from a pure mineral by a charcoal fire; whereas mine tin is usually corrupted with some portion of mundick, and other minerals, and is always smelted with a bituminous fire, which communicates a harsh sulphureous injurious quality to the metal."

Such is a description of the furnace of the stream work blowing-house, in use in Devon and Cornwall one hundred years since, and which was introduced by the Germans into this country over three hundred years ago.

George Agricola, a physician and eminent authority on mining matters, who was born at Glauchen in 1494, wrote several books on metallurgy, and on the working and management of mines. It is interesting to note how very old the bulk of the mining operations as carried on at present are. Our machinery of to-day is improved, and we possess the advantage of steam; but water-power mines are very similar in many respects to those in operation hundreds of years since.

A German edition of Agricola's great work was published at Basel in 1621, and another in Latin at the same place in 1657. Both are profusely illustrated from the same blocks, with spirited and well-executed engravings descriptive of mining and smelting operations.

Some of the impressions are marked with a monogram composed of the letters R.H.M.D. with a dagger, the cypher of Rodolphus Manuel Deutsch, an engraver who flourished about 1548.

Agricola's work was therefore prepared about three hundred and forty years since.

In the previous paper[7] a description was given of the ruined blowing-house situated close to Week Ford. This ruin was so choked with debris and overgrown with vegetation that a close investigation was impossible. Having obtained from Mr. Barrington,[8] the Duchy representative on Dartmoor, the requisite permission, the writer determined to remove the debris with the view of making a careful examination of the interior. Great care was taken that nothing but loose stones were moved, and that the structural portion remained intact. The entrance was first cleared, laying bare the footstone and a grooved stone which partly carried one of the jambs of the door. Inside, another grooved stone forming a further instalment for the same purpose was found. In addition to this, five irregularly shaped stones, the whole of them more or less broken, and with none of the circular or oval shaped cavities perfect, were unearthed. One had five such cavities, another four, another two, and a smaller fragment one. The fifth was found close up toward the south end of the ruin, as if it had been thrown in from the higher ground, which here slopes up toward the south. This stone had three circular cavities on each side, similar to but larger than that which was found in a hedge at Riddipit. Close to the north-west angle lay a large stone having the rounded appearance of a river boulder. It was nearly three and a half feet long, two wide and two deep. On turning it over a perfectly smooth flat face was disclosed, having on its surface three slightly oval shaped cavities, two of which were quite perfect. The diameters of these cavities were respectively ten and a half inches by eight and a half, ten inches by eight, and nine inches by eight. These cavities were polished smooth, a result evidently obtained by attrition. This smoothness is characteristic of all the circular and oval shaped cavities, but this specimen having been so perfectly protected from weathering, possesses it in the greatest degree.

Close by this stone lay a portion of a rectangular mould, and

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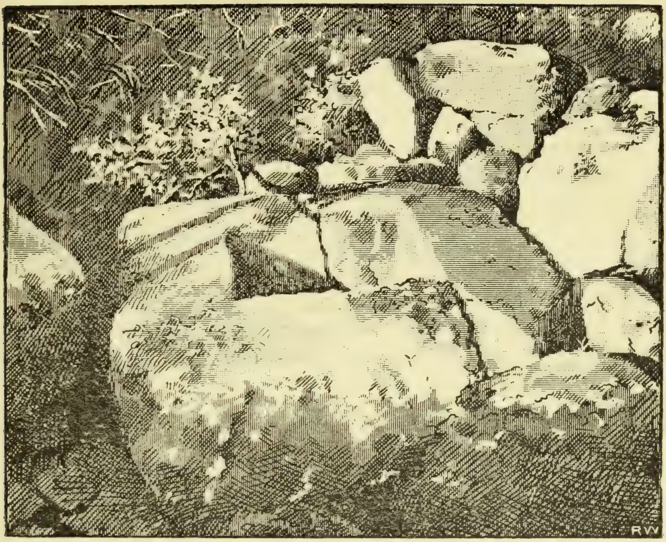
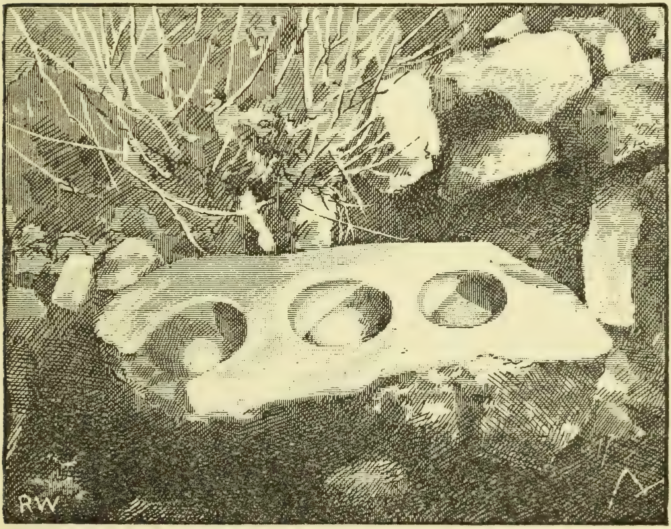
[7] *Trans. Plym. Inst.* vol. x. (1888), pp. 104–6.

[8] Since this I have received from Mr. French, of Dean Prior, a complaint that I should have consulted him as copyholder of the property. I acted in ignorance of this possession, and regret it.

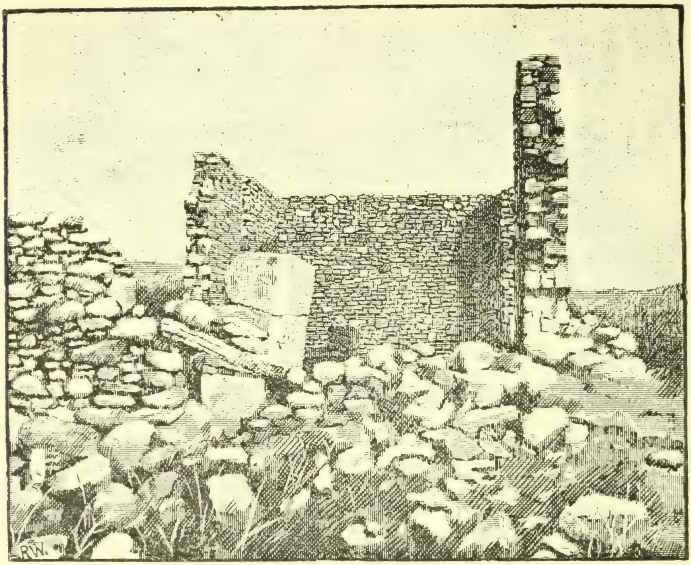


Mould stone unearthed at Week Ford.



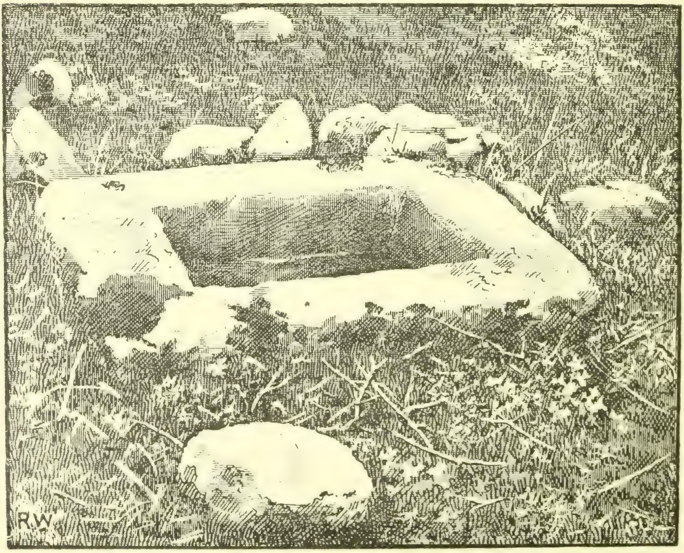
Mortar stone at Week Ford.

To face page 226.



Eylesbarrow Blowing-house (modern).

See page 235.



Mould stone at Post Bridge.

See page 240.

on proceeding further with the clearing, the remaining larger portion was found close under the door or window on the west side of the ruin. The two fragments were carefully pieced together, and the mould was found to be fifteen inches long at the top, with a width of twelve inches at one end and eleven at the other. It was bevelled, so that the bottom length was twelve inches with a width of nine and eight inches respectively. The depth of the mould was five inches. It had evidently been subjected to heat, for it was cracked in several places. It is curious that this mould is precisely of the same dimensions as that at Gobbett.

In clearing out this ruin, no timber, iron, or industrial object was found. There was no paving, the floor being composed of granite gravel, which in the dry makes a good hard working bottom.

There is very little doubt that these cavities are ancient mortars, and were used by the "old men" for breaking up the slags, so as to get at the prills or globules of tin contained in the same, or for pounding up the larger nodules of stream tin. They are not moulds; for they are too numerous and their interiors are too smooth to have been the receptacles of molten metal. The stones containing them are sound and solid, whereas the rectangular mould stones are usually cracked and weakened by heat. They cannot have been the bottom stones of primitive stamps, for if formed in the process of stamping they would have partaken more of the shape of a stamp head which certainly has never been round and pointed. They cannot have been formed by revolving crazing-mill spindles—their shape and number on a single stone forbids this. Had they been formed in this manner, ridges must have been produced in the hollows; there is however no sign of this, for the interiors are quite evenly smooth.

The traditionary idea among the moormen is that they were used for *beating up the tin.* This confirms the supposition that they were used as mortars. The pestle was probably of iron. None of these instruments have been found in the ruins. These cavities thus far have been noticed at Week Ford, Har Tor, Riddipit, and Gobbett. At the latter place they are associated with the remains of a crazing-mill, thus strengthening the idea that at this place, at any rate, they were used as mortars for breaking up the tin-bearing slags, the mill being employed in grinding down the tin stones preparatory to washing and smelting.

On the Gobbett site are heaps of broken-up slag, which still further confirms this opinion. The readiest and most effective plan for dealing with slag is of course by stamping, and the use of primitive mortars for this purpose tends to show that they must have been in use before stamps were generally employed, thus giving the blowing-house ruins possessing them a probable antiquity of at *least* three centuries. They may be much more ancient than this, but unfortunately there are no data at present available to guide the enquirer.

Whilst at Redruth, on the 14th of February last, the writer was informed by Mr. A. H. Jenkin that on the same day two granite stones, with eggcup-shaped cavities, had been laid bare in digging the ground in front of the new hospital, which is situated on an eminence known as Blowing-house Hill. It is interesting to note that the two cavities, one in each stone, are similar to those found on Dartmoor. The cavities at Redruth are circular, the diameter being eight to nine inches, with a depth of about six. A layer of charcoal was found near the stones, which were nearly two feet under the present surface of the field. This interesting find fixes the actual site of the blowing-house, which has given its name for an unknown period to the district.

What has been previously described under the name of the Har Tor blowing-house is situated high up on the head waters of the Meavy, and reference has also been made to the extensive streaming operations in the neighbourhood of this ruin. These stream works continue right down the valley to Sheepstor Bridge, with occasional traces much further down the river. The small tributary streams running into the river also bear traces of old surface mining operations.

There is a striking example of this at Hoo Meavy. Here the operations must have been extensive, for the cuttings are deep and wide, and the mounds of *débris* large. From the hamlet to the common close to Greenwill, the artificial ravine made by the "old men" has been planted with trees which are of considerable size, and form a delightfully-shady and picturesque road of about a quarter of a mile in length. These workings run across to Cadaford Bridge, a distance of about two miles. On the other side of the river they are continued up to and beyond Clearbrook. No blowing-house remains are now visible. If any existed they have been doubtless used in the construction of hedges or houses.

Although there is nothing so far down the valley of the Meavy indicative of early smelting operations, there are unmistakeable signs just above Leather Tor[9] Bridge, at a place marked Rithy Pit on the Ordnance Map, or, as it is pronounced and named in the map attached to Rowe's *Perambulation of Dartmoor*, Reddipit or Riddipit. Here are the ruins of two dwelling-houses, which were inhabited not many years since. By following the track a few yards further up the river bank from these ruins, some flat granite boulders forming the bottom of the rough roadway will be noticed. On examination these will be found to have on their surfaces curious oval and circular-shaped cavities, previously found and described at Week Ford, Gobbett, and Har Tor. What appears to have been the back of a house is still standing close by. There is a recess formed by the modern hedge builders, who apparently constructed the boundary with the view of including this back wall, thus saving labour but using space, for they doubtless would have carried it in a straight line if the temptation of a standing wall had not diverted their course. The material of this ruin was doubtless a fine deposit from which the houses lower down were partially constructed, and what was left the hedge builders would gladly avail themselves of. There is evidence of the former in the shape of a small stone with a circular cavity in it, in the westernmost ruin; and also of the latter, for close to the site of the ancient remains is a curious stone, with a circular cavity on each side. It is built into the hedge, and is similar to that described by Mr. Amery at Gobbett (since disappeared), and likened by that gentleman to the top of a headsman's block. The stone in the hedge at Riddipit is nineteen inches long. The lower cavity is nine inches in diameter and three deep, whilst the upper is six inches in diameter and two deep.

On one boulder in the roadway are four cavities, six to eight inches in diameter and four to six inches deep. They are in pairs side by side, each pair forming a shape similar to the figure 8.

Two other boulders have a single circular cavity on each.

These are not the only remains indicating ancient workings, for close by is a dome-shaped stone with a flat and perfectly smooth base, nineteen inches by fourteen. The stone is eighteen inches high, and the rounded top has two triangular holes about an inch deep and some two inches apart, with a hole between which appears to be round, and contains a small iron plug run in with lead.

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[9] Anciently "Ledder" Tor.

The native previously referred to said it was formerly used as a weight. It may have been employed for this purpose, and the iron plug in the central hole might be the remains of a hook, although the size of this hardly appears sufficient to carry so heavy a weight. Whatever it may have been recently used for, it has all the appearance of originally serving the purpose of the upper stone of a small mill, such as might have been used for hand power only. The smoothly ground base and triangular holes in the top for the reception of prongs which carried the cross bar favour this assumption.

Running east of Riddipit is a gully which has been streamed. It terminates about a quarter of a mile distant, at the remains of Keaglesburrow mine, which ceased working in 1810. Here also may be seen evidence of mining operations of an ancient character, and quite unlike the ruins of the modern mine.

A little further east is Clazywell Pool. It is about an acre in extent, and has been excavated out of the slope of the hill facing south. When well filled with water it has a depth of from fifteen to twenty feet. The banks on all sides, excepting the south, are high and steep. Here the tin probably "bunched," and hence the pit. The only other pool like this on Dartmoor is that of Bradford, or Bradmere, near Drewsteignton, which however is larger and said to be much deeper. Although the latter sheet of water has excited the imagination of those who see the Druids' handiwork in all the riddles of the Moor, the popular notion that it was connected with tin mining is correct.[1]

From the southern side of Clazywell, a deep stream-work leads down to and intersects the rough moorland track which runs from Kingsett to Nuns Cross and Whiteworks. Across the track and under the northern boundary of the adjacent field is a ruin, but there is nothing particular about it to determine its character. The whole of the valley right up to Nuns Cross has been pulled about and disturbed in a most remarkable manner. The ruins of Plym Consols and Nuns Mine can be more plainly seen, but the more ancient remains have been buried up or obliterated.

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[1] Mr. Ormerod states, in an article on "Tin Streaming near Chagford," in vol. i. of *Devonshire Association Transactions*, 1866, that the water in this pool has accumulated during the last seventy years.

If the tin obtained was at all commensurate with the amount of work performed in this valley, it must have been large, and shows remarkable activity, extending probably over a long period. Opposite Kingsett—the name has a mining smack about it—and across the stream, is a ruin, so overgrown with vegetation and covered up with débris that it is impossible to say what it was. In the entrance, which is on the north side, is a stone with a cavity twelve inches long and seven wide at one end, and five inches at the other, with a depth of three to four inches. The ends of the cavity are rounded, the interior rough, and not bevelled. It could not have been used as a mould, and it is too small and shallow for use as a trough.

The valley washed by the brook which flows down from under Eylesbarrow between Sheepstor and Down Tor, joining the Meavy at Nosworthy Bridge, has been also streamed to a considerable extent. There are ruins of former habitations, and high up in the valley, close to Deancombehead farmhouse, is a gorge containing two caches, somewhat similar to that previously described at Deep Swincombe. The first is about one hundred yards south-east of the farmhouse, and the second about one hundred and fifty yards further up the gorge, with a cover stone formed by a flat boulder, resting very insecurely on a dwarf wall of dry masonry. Like the cache below, it was in a concealed position.

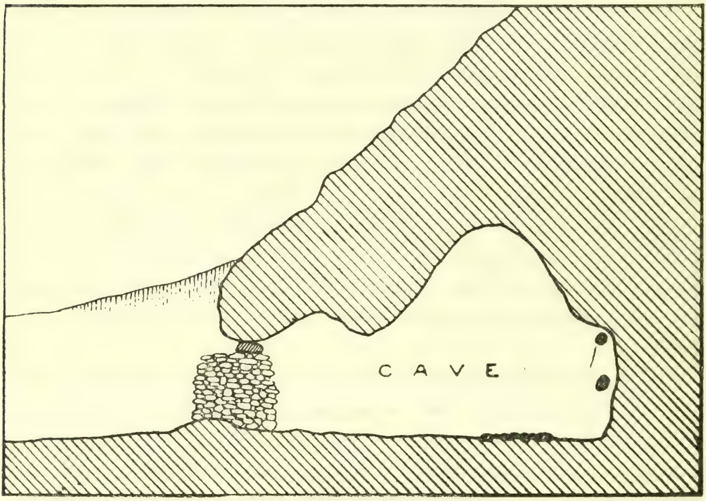
Whilst searching the deep ravine made by the "old men," the writer's son Lawrence discovered an entrance which appeared to lead to a cave. The approach was through a curved open trench twenty-three feet long, and led to a doorway three feet high and three wide. It was found on examination that the door was gone, but the posts and lintel of worked granite were still in perfect condition.

After clearing away the ferns, which quite concealed the entrance, a candle was lighted and the interior explored.

Inside the doorway a tunnel nearly nine feet long, and through which it was necessary to proceed stooping, led into a chamber scooped out of the rotten granite about nine feet long by seven feet eight inches broad and nearly ten feet high. The roof of the chamber was dome-shaped, partly produced by portions of it falling down—as a rough gravel—until the floor had been covered to the extent of a foot or more. Choked up among this were found half-a-dozen good sized stones, which could not have served any useful purpose unless they were employed to block up the entrance from the inside.

On clearing away the whole of the *débris* the original floor was exposed, and it was found that a portion of it had been paved with flattish stones as large as two hands, with some rather larger.

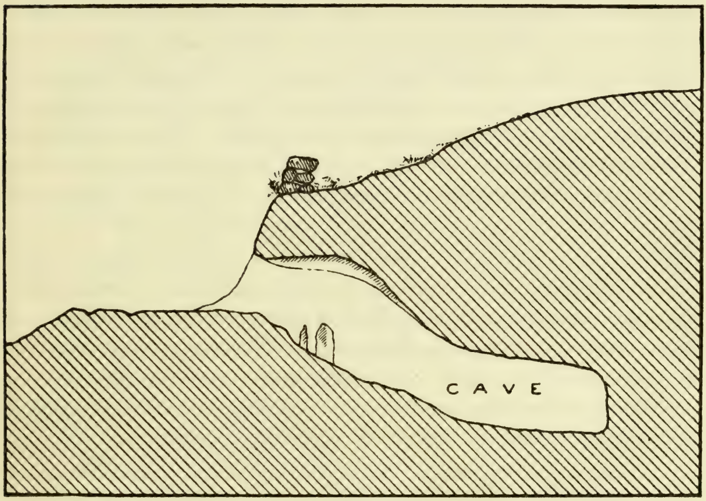
In the sides of the chamber were three square niches, such as might have been used for resting the ends of timber baulks in or for sconces for candles or lamps. Without being decidedly wet the cave was damp.



Deancombehead South Cave.

A careful examination of the loose material and the floor yielded nothing in the shape of industrial or other objects. It was probably used as a storehouse for the black tin streamed in the neighbourhood. A very little preparation would effectually conceal the entrance and defy detection.

Across the stream, and about north-east of Combehead House, and distant about two hundred and fifty yards, is another cave. The entrance is concealed from the south by a short dwarf hedge running in a westerly direction. A hole underneath a huge boulder descends into a gallery, which runs eastward, with a shorter branch in a northerly direction. The total length is twenty-two feet six inches. The greatest width is fourteen feet, whilst the inner recess is six and a half feet wide. The height from floor to roof is five feet. The entrance is three feet six inches high with a width of three feet. This cave is dry, and would make a capital storehouse and occasional shelter.



Deancombehead North Cave.

Both the East and West Glaze have been extensively streamed. Just above Glaze Meet, where these two streams unite, is a remnant of an ancient wall, and a little further on in the plantation are two heaps of moss-covered stones which appear to indicate the sites of old buildings. They may have been connected with the "old men's" workings, but there is nothing characteristic about them to settle this point. At this place a moorland trackway leads across the brook over a carefully-paved ford, taking an eastward direction towards the Avon. Another well-worn path, suitable for packhorses, follows the East Glaze up to Three Barrow Tor, and can be traced to Eastern Whiteburgh. This, with the numerous hut circles near, indicates that at some period it was a well-frequented district.

In concluding the last paper, reference was made to a cache or hiding-place for metal or tools, situated above the ruined blowing-house at Deep Swincombe. As previously mentioned, there are two more in the stream work close to the caves in the Deancombe Valley, which may have been used for the same purpose or for temporary shelter.

There are also small huts of a circular shape to be found in stream works, which are too small for habitations, but doubtless served the purpose of small storehouses. All that have been examined are covered with small mounds of earth and turf, and were very easily and effectually concealed. Even in their present condition they are not easily detected, especially if approached from the back, and the entrance out of view. The roofs are of the bee-hive pattern, and are formed of stones placed one on the other, with each stepping nearer the centre, until a larger stone placed on the top completes the arch. Mr. Spence Bate has described some of these huts on the Avon and Erme. That which is on the right bank of the latter river in a stream work running down from Staldon Moor is quite perfect, and is just six feet long, four wide, and three high. The entrance to this hut is defended by a dwarf wall, which served not only for concealment, but also as a barrier, should the brook, on whose bank it is situated, rise in flood. There is another hut similar to this, also in the midst of "old men's" workings, at Ladle Bottom, about two and a half miles above Post Bridge on the East Dart. The roof is partly broken in, but sufficient remains to show that it is of precisely similar construction. These ancient store-huts are of great interest, and it is to be hoped they may long remain as examples of the manner in which such curious little buildings were erected.

At the head of the Deancombe Valley, rising nearly 1500 feet above sea-level, is the hill crowned with the tumulus known as Eylesbarrow, or, as it is spelt in the ancient map defining the boundaries of the Forest of Dartmoor, *Elysburgh.* This has been for centuries a tin-bearing centre, and near it are extensive prehistoric remains. Not far from Eylesbarrow, but closer to Down Tor, are the remains of a fine avenue of upright stones about a thousand feet long, leading from a circle to a circular pound a hundred feet in diameter, with a tumulus close by the latter. For miles around the valleys and shallow depressions have been seamed and scored in all directions in the search for tin, whilst a little below the tumulus on Eylesbarrow are the ruins of a modern tin mine. According to Messrs. Lysons there were three tin mines at work on Dartmoor in 1820; viz., Vitifer, near Post Bridge; Whiteworks, near Princetown; and Ailsborough, in Shipstor. Mr. Burt, writing in 1826, adds that the latter had a smelting-house, where one hundred blocks of tin were coined for the Michaelmas quarter of 1824.

This is the latest and the last of the Dartmoor blowing-houses. It is situated about three quarters of a mile south-west of the mine-house ruins, and consists of the remains of a building sixty-four feet long and twenty-four feet wide. The walls, which are still standing to a height of from fifteen to twenty feet, are well built with rubble masonry laid in mortar. Portions of the furnace, consisting of massive stones, one of which is slagged, are still to be seen. The flue also, leading from the furnace, can be easily traced to the ruins of a small stack. This smelting-house was in use sixty-five years since, and was probably erected in the first quarter of the present century. It is quite unlike any of the blowing-houses which have been already noticed in this or the previous paper on the same subject.

The remains of streaming operations in the valley of the Erme, from Harford Bridge to the head of the river, are of an extensive character. In following the river upward, several ruins of rectangular huts are met with, but only one is of an undoubted blowing-house type. This is situated close to the junction of Hook Lake with the Erme, or nearly half a mile below Erme Pound. My attention was first drawn to it by Mr. Crossing. The ruin in question is twenty feet long by twelve feet wide, with a wall dividing it into two compartments. The building runs almost east and west, with an entrance four feet wide into the western compartment. The walls are built of rough stones dry laid.

In the western compartment is a large stone which has been broken longitudinally, and more than half of it removed. The portion remaining is five feet long, two wide, and two deep. It contains one perfect and three imperfect cavities. One of the imperfect cavities is thirteen inches long, seven inches deep, and is evidently the remnant of a rectangular mould. There are also the remains of two small cavities, each about three inches long, two inches wide, and two inches deep, similar to the small cavities already noticed in one of the mould stones at Gobbett.[2] The perfect cavity is twelve inches long, three inches wide, and three inches deep, and appears to be similar to the cavity found by the late Mr. Kelly, and mentioned by that gentleman in a communication which is contained in the *Journal* of the Royal Institution of Cornwall for 1866. There are no circular or oval cavities visible.

The streaming operations in Stony Bottom, through which the Hook Lake flows, are considerable, and indicate great activity among the tinners in this neighbourhood. Close by are many groups of hut circles, in several cases surrounded by ruined walls forming enclosures or pounds.

That which is known as Erme Pound is of considerable extent, and encloses a dozen hut circles. This pound is figured in the fifteenth century map of Dartmoor, which delineates the Perambulation of 1240, and was doubtless in use many centuries since for herding cattle. Outside, and between the pound and the Erme, are two ruins of rectangular buildings which may have been tinners' huts, or were used in connection with the pound. One ruin is curious, for it possesses a bench composed of flat stones, which run around both sides and one end, and having somewhat the shape of an horseshoe.

About one and a half miles above Erme Pound are more extensive stream works, with coffins or open trenches and excavations, known as Erme Pits. The heaps of *débris* here are gigantic, and one pit is both large and deep. They were worked two hundred years since, for they are referred to in *Metallographia; or, An History of Metals, by John Webster, Practitioner in Physick and Chirurgery*, published in London in 1672. The author in the chapter on tin refers to Dartmoor as follows:

> "Now I shall give the Reader such informations as I received from one *Thomas Creber* of *Plimpton S^t Mary* in *Devonshire*, who was one (and all his ancestors before him) that had wrought in the Tin-mines; and these particulars I had of him.

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[2] Since writing this paper the author has investigated the ruins of two more blowing houses situated on the Walkham above Merivale Bridge. Both have very perfect mould stones, containing in addition to the mould a small cavity in each; the latter are evidently intended for sample ingots.

"1. The hills where they get Tin Ore, near that place where he lived, are called *Yelsbarrow*[3] and *Woolack.*[4]

"2. Black stones that hold Tin, they call Tin-stones and lie either in a load, or in a string.

"3. There is other Tin ore that is softer, and lies in a dun stone, and is of a yellowish colour, but will melt neer both alike.

"4. Pure ore, which they call Corn Tin, being found in grains, and is the hardest to melt.

"5. Another place they called *Armed Pit* (*i.e.* Erme Head Pit) which holds Ore they call *Zill Tin*, which is as small as grit or sand, and needeth nothing but washing, and is the most easily melted of all other sorts of Tin Ore, and lieth in chalk and clay; and this small Ore, because it is rich, they call it fatty Ore.

"6. The black stones, if they find them at the top, do continue in the whole Mine or Work. Sometimes it is in that they call strings, running through earth, or stones, like small twigs or strings: and sometimes it is all in one, like a great branch or trunk, which they call a Lode. Sometimes it runneth in Spar, sometimes in a black stone that will strike fire, sometimes in white stones that are soft.

"7. Their smelting-houses roofs, after certain years they pull down, and find store of Ore in that stuff, that in their former . . . . . . meltings was forced from the fire.

"8. The Corn Ore is found at the bottom of the Hills, being there digged into, and lieth sometimes in one sort of earth, and sometimes in another. And the Zill Ore is found in the same order.

"9. The uppermost part of their Work they call Cooping; and if it be good or rich, the Lode or Strings underneath are good: if bad or indifferent, those underneath, are sometime good, and sometime bad.

"10. They call that part of the mineral, that is found washed down into the valleys, Shoad.

"11. They have a thing they call Mundick, sometimes found in the Ore, which they separate lest it should spoil the Ore; some of it is yellow, which is the worst, and sometimes of other colours: and the Mundick after smelting the Ore, is blackish and hard. Of it Mr. *Boyl* saith thus. Mundick I have had of a fine golden colour; but though it be affirmed to hold no metal, yet I found it in weight, and otherwise, to differ from Marchasites, and the Mine Men think it of a poysonous nature.

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[3] Eylesbarrow in the parish of Sheepstor.

[4] In the Court Roll of May 14, 13 Henry VIII., A.D. 1521, mention is made of a rental of 3d. to be paid by Richard Cole and Thomas Hele for a mill called *Wallack Mill* and two acres adjoining in the Forest of Dartmoor. This hill is probably *Wallabrook Girt.* Lake and brook means the same thing. *Wallabrook* probably became *Wallalake*, and then further corrupted to *Wallack* or Woollack.

"12. They have a thing called *Maxy*, mixt with the Ore, which cannot be separated by the water, but by the fire, and then smells very ill, and is of a blewish colour.

"13. Lastly, They also find something like bright Ore, which they call *Shim*."

The Doctor concludes by saying:

"And thus much of this Metal, seeing there is no need to speak of any Mendicaments prepared forth of it, because I have not had experience of any such."

This technical description, communicated by a Dartmoor tinner in the seventeenth century, is interesting, and throws a little light on a subject which is at present very obscure.

If there be one district in the Forest of Dartmoor which shows more results on its surface of the work, both of ancient and modern miners, than another, that district lies near Post Bridge. Stream works abound in all directions, testifying to the activity of the "old men," whilst the ruins of modern tin-mines are dotted about for miles. The greatest interest, however, in this district centres at the Furnum Regis, or King's Oven. This smelting-place is mentioned in the *Perambulation of Dartmoor*, made in the twenty-fourth year of the reign of Henry III., 1240. In the ancient map defining the limits of this Perambulation it is shown as a large circle lying between Wellabroke, and Capud Wallebroke, or the head of the Wallabrook, which stream flows into the Dart.

The Furnum Regis is mentioned simply because it falls on the line of this Perambulation, and not a word is said which indicates whether it was the king's furnace of that time, or of some previous period. It is probably much older than the thirteenth century, and is without doubt the most ancient remains of a smelting-place on Dartmoor. It lies about four hundred yards almost due north of the "Warren House Inn," or about two and a half miles from Post Bridge, and consists of a circular enclosure of about seventy-two yards in diameter. The wall, forming the enclosure, is composed of small granite stones, and is in ruins. In the centre of the circle is a roughly-worked rounded stone, three feet in diameter, and close by it is a small pile formed of stones with one end rounded.

These smaller stones were taken away from the enclosure with the view of using them in a modern mine-house now standing in ruins close by, but before they were absorbed in the building the spoliation was discovered, and they were returned, but whether again placed *in situ* is not known.

On the southern side of the circle, and connected with it, is the remnant of a small rectangular building; but for what purpose it was used, or whether it is a more modern addition, is uncertain. But for the fact that the Furnum Regis is mentioned in the earliest recorded Perambulation, it could never have been recognised as a smelting-place. It presents the appearance of a circular enclosure, very similar to others to be found on the Moor.

The district near King's Oven must have been at some period, or perhaps in succeeding periods, very fairly inhabited, for ruins of hut circles abound. The well-known Cyclopean enclosure known as Grimspound is not far distant, whilst near Post Bridge are others, all being situated in or near ancient stream works. Post Bridge itself is doubtless a settlement of considerable antiquity, for some of the houses, particularly that of Higher Merripitt, present the appearance of great age. A district formerly so rich in stream tin, and so extensively worked as this has been, must have possessed blowing-houses for smelting the black tin which was streamed and raised during the period between the time when the Furnum Regis was in work—whenever that might be—and the 17th and 18th centuries.

Unfortunately the modern craze for the conversion of Dartmoor into fertile crop-bearing ground and richer pasturage, a craze which was rampant in the earlier portions of this century, has been the means of destroying many objects of great archæological interest. The "new-take" wall builder has been a great sinner in this respect: mediæval crosses with the arms knocked off made fine gate-posts, and blowing-house ruins a splendid deposit from which handy stones could be selected with little trouble and labour. It is no wonder then that the difficulty of recognising sites of smelting places in certain localities is so great. Diligent search in the Post Bridge district has not however gone unrewarded, for the writer found, close to the clapper bridge, an object which proves the former existence on this spot of a blowing-house.

A few yards below the bridge, on the right bank of the river, is a ruin known locally as the "Barracks." This building was erected some years since as a residence for miners, and the discovery on the spot by the writer of what appeared to be a mould for tin, cut in a large block of granite, caused him to make enquiries which resulted in the establishment of this place as the site of an old smelting-house. Jonas Coaker, the Dartmoor poet, now in his 89th year, recollects that when very young this spot was by tradition regarded as the remains of a blowing-house; and George French, of Post Bridge, has also heard the same. The latter says it was regarded in his younger days as a former central smelting-place for the neighbourhood, and that the tinners all over this part of the Moor used to bring their black tin here to be blown.

The Rev. John Shattock, who resides close by, discovered another mould a few yards south of the first. It is close under the wall of a small ruined outhouse. The moulds are almost of exactly the same dimensions, being at the top two feet long, fourteen inches wide, and nine inches deep. They are bevelled, so that the bottom length is sixteen inches, with a width of eight to nine inches. They are therefore intended to turn out ingots of about the same weight. These moulds are symmetrical, and well and carefully wrought in large solid blocks of granite, sunk into the earth so that the top of the mould is nearly flush with the surface of the ground. They are the largest and best-made moulds of any of the numerous examples previously described.

The ingots made from such moulds would correspond in shape and weight with the tin imported into Italy from Devon and Cornwall during the fourteenth century, and also with the blocks described by Carew in the seventeenth century. As we are told by Chapple, in his *Review of Risdon*, 1770, that Devonshire mining had then sunk into insignificance, and as this was a traditional smelting-place a century since, it is probable that we must go back to the seventeenth century, at least, for the time when this site was occupied by a working blowing-house. From Furnum Regis to this there is a blank of many centuries. Thus far no intermediate remains, between these periods, have been found in this locality. It is mostly by comparison that any idea at present can be formed of the age of the blowing-houses already described. We know that in the sixteenth century streaming was very active on Dartmoor, and it is highly probable that some of them date from about this period.

At Week Ford, the oak trees growing in the lower ruin prove that this place has been in a ruinous condition for a lengthened period. One of these trees has a trunk circumference of five feet six inches. In Wistman's Wood there is a large triangular-shaped boulder with the following inscription: "By permission of H.R.H. the Prince of Wales, Wentworth Buller, on September 16th, 1866, cut down a tree near this spot; it measured nine inches in diameter, and appeared to be about 168 years old." If this estimate be correct, and if the growth of this tree and that at Week Ford proceeded in anything like the same ratio, it would give an age to the latter of something like four centuries. The tree at Wistman's Wood had to contend with an elevation of about 450 feet more than that at Week Ford, and would therefore have a slower growth, so that although a mere comparison of size may be made to roughly approximate the difference of ages in the two trees, too much reliance must not of course be placed on such an estimate. Living persons remember the Week Ford ruin, or "Beara House," as it is sometimes called, for fifty years and more, in precisely the same condition as it now is, and with no apparent appreciable growth of the trees. Taking into consideration the whole of these circumstances, it is tolerably safe to assume that we have to go back some three or four hundred years before we reach the period when this place was smelting stream tin. It is impossible to indicate, with any degree of certainty, the age of the remains at Gobbett or on the Yealm and Erme. The only thing similar about them is the stone moulds, but as a type of mould might have been in use for a lengthened period, they do not help us forward in the desired direction. Some may be comparatively modern, whilst others may be of respectable antiquity.

The primitive blowing-house at Deep Swincombe, with its single and peculiarly shaped mould cut into the face of a huge boulder, is probably the most ancient of all the rectangular smelting-places yet noticed on Dartmoor. The district in which it is situated, possessed at any rate sufficient importance to be mentioned in the earliest Forest records.

Whilst active streaming and mining operations were going on in this district agriculture was not neglected, for we gather from the bailiff's account of the manor of Dartmoor, A.D. 1379, that 1½d. was paid for an acre of land in Hextworthy—near Deep Swincombe—let to John Browning; and also 3d. for two acres of land in Bysouthexworthie let to John Holrig.

The summering of cattle on the Moor must be a very ancient custom, for as early as 1305 there is an entry that *Donebrugge*, *i.e.* Dunnabridge, arrented this year to Richard Rauf, Hamlin de Sherwell, William Togot, Richard Steven, and James de Woghby; whilst thirty-eight years later credit is given in the Duchy Accounts for a lock bought "for the gate of the Pinfold at Donnabridge." We thus gather that, five or six centuries since, mining, agriculture, and cattle-grazing flourished side by side, finding employment for numbers of men who have left traces of their handiwork and industry scattered all over the Moor.

THE BLUE FRIARS: A NOTABLE PLYMOUTH BROTHERHOOD.

SYLLABUS OF LECTURE BY W. H. K. WRIGHT.

(Read 28th March, 1889.)

THE Blue Friars and the Plymouth Institution. The origin of the fraternity supposed to be involved in mystery. The Blue Friars not a religious institution. Extract from *Blue Friar Pleasantries* respecting the origin and purpose of the order. Canons. The original "Four" and their monastic appellations. The mystery explained, and the identity of the brethren revealed. Discovery of the "Blue Book" containing the "Records" of the order. The Blue Box and its interesting contents. Lay brethren and their appellations. Some notable members of the order. Brother "Prism," the "Blue Cardinal," and others. Introduction of the "Blue Friars' Sauce." Notes of various conclaves of the order, with descriptions of monastic garb. Interesting refectory items. The emblems of the order. Death and the friars. Dispersion of the fraternity. Biographical notices of some of the leading friars.

ON AN ANCIENT BURIAL URN FROM THE CHEESEWRING DISTRICT.

BY R. N. WORTH, F.G.S.

(Read 1st May, 1888.)

AMONG the additions to the Museum of the Plymouth Institution during the present year are the fragments of an ancient burial urn from a barrow in the Cheesewring district. The age and ornamentation give it exceptional interest, for it is hand-moulded and sun-dried; of very high antiquity; and the decoration is more elaborate, with one exception only, than that of any other British burial urn discovered in the county.

It was found by some men who were engaged in removing a barrow—which appears really to have been a cairn—consisting mainly of stones, but was so fragile that it broke to pieces in the process of removal. It was described as having been oval, about two feet in length by eighteen inches in depth; but an examination of the fragments shows that while it may have been deformed by pressure in the cairn, the original shape was undoubtedly intended to be round, and that little reliance can be placed upon the guesses made as to its dimensions.

It contained ashes and calcined human bones; and had in the centre a smaller vessel, described as resembling a small plate with a hole in the centre and a raised rim, supported on four little legs or pillars. Probably this vessel, no portion of which was preserved, was simply a small broken urn, or what is sometimes called a food vessel, such as is not unfrequently found in kists, and occasionally in the larger urns.

The material of both the larger and the smaller vessel was the ordinary coarse granitic clay of the locality — sun-dried, but hardened and blackened by the ashes of the funeral fire.

Taking the curves of the larger fragments, which fortunately represent the upper part of the urn, we find that they give a radius of between seven and eight inches. This would indicate a diameter at the mouth of about 15 inches; but as the sides rounded out somewhat below, the extreme diameter was certainly sixteen inches, which the two handles would increase for the total breadth to twenty. The breadth at the bottom can only be guessed at, the largest fragment of this part being 6¾ inches by 5⅞ inches; but in all probability it was about a foot.

There is much the same difficulty with regard to the height. The largest piece of the side is 7½ inches by 6½ inches, and the whole of this is ornamented. It is not unusual in these urns to find the ornamental portion occupy a third of the total height; and I think the probability is that in this case the height was 21 or 22 inches.

The handles are an exceptional feature, absent from the majority of examples of this funereal pottery. The one which has been preserved is 3¼ inches by 3 inches, and stands out 2 inches from the fragment of the urn to which it is attached. There is an irregular hole through it, varying from 1⅛ in. to 1⅜ in. in diameter—the longest diameter being vertical on one side, horizontal on the other. The vessel has apparently been carried by a cord of some kind passed through these holes. The urn swells out into a ridge near the attachment of the handles; and the inner edge of the lip is neatly chamfered. The rim is generally about half an inch thick, but at parts only a quarter; at the base of the chamfer it is three quarters. The average thickness of the urn is about half an inch; but parts of the bottom are seven-eighths.

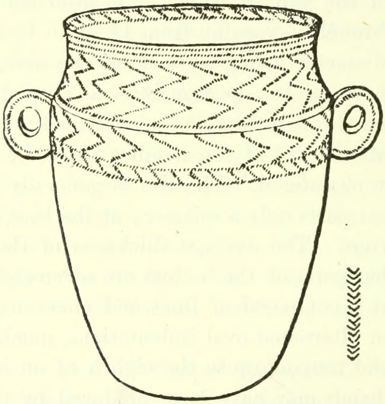
The ornament is composed of lines and chevrons, chiefly made up of coupled or alternated oval indentations, much like a willow leaf in shape, and ranging up to the eighth of an inch in length. Some of these bands may have been produced by the pressure of a roughly-twisted cord; but some must have been impressed directly by hand, and with no little skill.

Inside the rim there is a pattern composed of two single rows of these indentations with double diagonal rows between.

On the outside the pattern begins with three double horizontal rows of dentures, which occupy an inch in depth. Below this 2⅔ inches are filled in with vertical chevrons—each line being composed of the coupled markings. The chevrons are about 1½ inch deep across the base of the opening, and about the same breadth from an imaginary base line to the point. Beneath the chevron band is another double row of dentures; then comes a projecting band, continued downward in the contour of the urn; and then again more chevrons. How these were finished there is no direct evidence; but another fragment indicates a pattern composed of two lines of single dentures, with regular diagonal lines of single marks between, somewhat resembling the ornament of the inner rim, and this was probably the termination.

The handles are ornamented round the holes by a band of coupled markings. On the exterior faces there are three lines of coupled dentures dividing the space into one large semi-central and three smaller side panels. The central division is filled in with a row of chevrons; each side division with diagonal rows.

The character of the urn and of the ornament will however best be gathered in all probability from the restoration annexed. At the side is indicated the arrangement of the coupled markings.



I may add that the urn was shown to Mr. A. W. Franks, F.R.S., F.S.A., of the British Museum and Christie Collections, and that he agreed that it was British, and of high antiquity.

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